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ABSTRACT

A report on U.S. graduate education that focuses on issues of financing arts and sciences programs is presented by the Graduate Education Subcommittee of the National Commission on Student Financial Assistance, chaired by John Brademas. Study objectives were to determine: adequacy of sources and levels of support for graduate students, financial constraints to graduate school attendance by talented students, growing levels of indebtedness of graduates, and underrepresentation of disadvantaged groups in various fields of graduate study. The need for new or modified federal aid programs for graduate students, especially in the humanities and social sciences, was addressed. After reviewing the importance of graduate education and research, the following problems are considered: maintaining a high quality faculty; the loss of talented students; and inadequate equipment and library collections. Reasons for the erosion in the graduate enterprise are addressed, including demographic shifts, the academic market, federal support, and cost problems. An agenda for federal action and 10 recommendations are suggested. Appendices include: a list of witnesses offering testimony, information on issues relating to graduate student finance, discussions of the participation of minority groups and female students, and a three-page bibliography. (SW)

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National Commission on Student Financial Assistance

The National Commission on Student Financial Assistance was created by Public Law 96-374, The Education Amendments of 1980. Deliberating on those amendments, Congress realized there was a general lack of reliable information and well-informed policy recommendations on many fundamental issues of federal student assistance in post-secondary education. The National Commission was established to respond to this situation and to provide policy recommendations to Congress and the President.

Established in 1981, the National Commission is a bipartisan panel of members of Congress, leaders of the higher education community, and representatives of the public. The Commission is composed of twelve members, four appointed by the President of the United States, four by the Speaker of the House of Representatives, and four by the President Pro Tempore of the Senate:

Appointed by the President

David R. Jones, *Chairman;* member of the faculty, Vanderbilt University

Richard E. Kavanagh, Senior Vice President, Shearson/American Express Inc., Chicago, Illinois

Marilyn D. Liddicoat, Attorney-at-Law, Santa Cruz County, California

Kenneth R. Reeher, Executive Director, Pennsylvania Higher Education Assistance Agency

Appointed by the Speaker of the House of Representatives

John Brademas, President, New York University; former Member of the House of Representatives

Hon. John N. Erlenborn, Representative from Illinois*

Hon. William D. Ford, Representative from Michigan

Kenneth G. Ryder, President, Northeastern University

Appointed by the President Pro Tem of the Senate

David P. Gardner, President, University of California System

David M. Irwin, Executive Vice President, Washington Friends of Higher Education, Seattle, Washington

Hon. Claiborne Pell, Senator from Rhode Island

Hon. Robert T. Stafford, Senator from Vermont

*Replaced Hon. Wendell Bailey on February 24, 1983.

National Commission on
Student Financial Assistance

Memorandum of Transmittal

To: Hon. Ronald W. Reagan
President of the United States
Hon. Thomas P. O'Neill, Jr.
Speaker of the House of Representatives
Hon. Strom Thurmond
President Pro Tempore of the Senate

From: David R. Jones
Chairman of the National Commission on Student Financial Assistance

It is with great pleasure that I submit to you the final report of the Graduate Education Subcommittee of the National Commission on Student Financial Assistance, entitled, "Signs of Trouble and Erosion: A Report on Graduate Education in America."

I am delighted for several reasons to present this report to you and to the American people. First, it represents a significant contribution to the growing body of literature that has focused national attention on American education. This study examines the state of research, scholarship, and training at the most advanced levels of our educational system.

Second, the analysis presented in the following pages speaks to a number of audiences: to members of the academic community, to leaders in government, and to the public at large. This is a report that can—and should—receive a wide readership.

Finally, this study comes at a crucial moment. As stated in the report, "The problems identified...although serious, represent initial signals to which all of us must attend. The objective of the Commission is to assure that, ten years from now, the nation not look back on these signals as the alarm it failed to heed." As Congress considers legislation to reauthorize programs of federal support for colleges and universities and their students, this report will serve as a most timely and useful guide.

I commend Dr. John Brademas for the excellent job he has done in chairing the Graduate Education Subcommittee and for producing, along with Senator Claiborne Pell, Marilyn D. Liddicoat, and David M. Irwin, a document that will, I am confident, help chart the future of graduate education in America.

David R. Jones
Chairman
National Commission on Student Financial Assistance
Washington, D.C.

Dear Mr. Chairman:

On behalf of the members of the Graduate Education Subcommittee of the National Commission on Student Financial Assistance, I am most pleased to transmit to you our final report.

At the outset, I should like to express my warm appreciation to my colleagues on the Subcommittee, Senator Claiborne Pell, Marilyn D. Liddicoat, and David M. Irwin, for the energies, insights, and judgments they brought to bear in shaping this document.

Over the last year, the nation has seen a steady stream of reports from commissions, task forces, conferences, study groups, and individual scholars on the status of schooling in America. In the judgment of the members of our Subcommittee, our analysis of another crucial aspect of our national life—graduate education—supplements and reinforces the findings of these reports, which have dealt chiefly with education at the elementary, secondary, and college levels.

To place our report in perspective, let me briefly describe the activities of our Subcommittee. In the course of our work, we commissioned several research papers on such topics as graduate student indebtedness, why students are dissuaded from graduate study, and the underrepresentation of women and minorities.

Our Subcommittee also held hearings at Stanford University, the University of Southern California, and New York University at which we listened to university and industry leaders as well as to graduate students express their views on problems in graduate education. Finally, we received testimony and comments from a wide range of higher education groups, graduate and professional associations, and university faculty and administrators.

A few points should be made about the scope of our study. First, it focuses chiefly on master's and doctoral programs in the arts and sciences. Second, we treat the health of the graduate enterprise as a whole. To view graduate research and graduate training as distinct matters is, we believe, to misunderstand the nature of the entire effort.

Third, and in keeping with our charge, this report emphasizes the responsibilities of the federal government to graduate education.

On the basis of our findings, we on the Subcommittee can report that the graduate enterprise in our country remains fundamentally strong. But we must also report that there are signs of trouble and erosion in the nation's graduate education and research capacity—signs that in some fields point to serious distress.

The recommendations in this report constitute an agenda for federal action to support graduate education. The ten proposals we make touch upon issues of student financial assistance; participation in graduate study by women and minorities; support of research; the state of laboratories, equipment, and libraries on the nation's campuses; the maintenance of faculty of high quality; the supply of highly trained experts in areas critical to the nation; and the need to gather and disseminate information vital to policy-making for graduate education. Our "goals for graduate education" are directed toward ensuring that the nation maintain a healthy, vital graduate enterprise, one that constitutes, as we say in the report, "the bedrock" of our national life.

This is a sweeping statement, yet we believe it justified. Indeed, the Subcommittee has determined that graduate training and research are crucial to the United States in three respects: first, to our economic health and productivity; second, to our defense, intelligence, and diplomatic capability; third, to the quality of life in America.

I wish to take this opportunity to express on behalf of the Commissioners our appreciation to all those persons who assisted us in the preparation of this report. We wish first to thank these members of the staff of the National Commission on Student Financial Assistance: Richard Jerue, chief executive officer; Robert Snyder, senior research associate, as well as Scott Miller, Donna Lumia, Barbara Kraft, Kristin Stelck, and Susan Turner. In addition, we express our deepest thanks to Michael O'Keefe, president of the Consortium for the Advancement of Private Higher Education and formerly with the Carnegie Foundation for the Advancement of Teaching, and to James Harvey, senior associate at the National Commission on Excellence in Education and

the National Institute of Education. In the preparation of our report, we relied heavily on the guidance and writing skills of Messrs. O'Keefe and Harvey. Lynne Brown of New York University also assisted significantly in this project.

We wish to extend thanks as well to the following foundations and agencies without whose financial support the Subcommittee would not have been able to complete its report: the Ford Foundation, the John D. and Catherine T. MacArthur Foundation, the Exxon Education Foundation, the Rockefeller Foundation, the Carnegie Foundation for the Advancement of Teaching, and the National Commission on Excellence in Education.

The members of the Subcommittee and I also wish to thank you, Mr. Chairman, for your support. We were honored to have had the opportunity to serve on the National Commission on Student Financial Assistance and to take part in discussing issues important to higher education and the future of our country.

Sincerely,

John Brademas

John Brademas,
Chairman
Graduate Education Subcommittee

Office of the President
New York University
70 Washington Square South
New York, New York 10012

December 1, 1983

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Introduction

Various task forces and commissions composed of distinguished citizens have recently directed public attention to serious problems in American elementary, secondary, and postsecondary education. This report of the National Commission on Student Financial Assistance examines another crucial aspect of our national life—graduate education.

The Graduate Experience

The essential graduate experience, that period of formal education following the bachelor's degree, has several common characteristics whether the field of study is Greek literature or molecular biology. The experience involves mastering the theory, body of knowledge, and modes of thought of a discipline; training in the skills, techniques, and tools of intellectual inquiry appropriate to that field; and applying that education and training to an original research problem that advances the discipline and adds to our core of knowledge. Education at the graduate level is designed to create not only new scholarship but new scholars as well—individuals with the capacity to learn independently, to define and attack new problems, to advance our fundamental understanding of the world, and to teach and explain what they have learned to others.

First-rate graduate education without original research is inconceivable. On the other hand, research, wherever it takes place, is directly dependent on graduate education—even research in industrial laboratories relies on graduate scientists.

The Graduate Enterprise

The health of the graduate education and research enterprise is one of the most significant educational issues this society faces. The nation depends upon its great universities for most of its fundamental research and for each new generation of scholars and scientists. By defining an ethic of excellence in education, our universities set the tone for the rest of the educational system. In turn, the universities rely on schools and colleges to nurture and develop the skills and talents of each new generation.

The Commission does not intend to treat in detail each of the wide variety of programs in our graduate institutions. These programs are multiple and diverse. Master's degrees can be earned in one or two years; doctoral and postdoctoral programs are rarely completed in less than four years of study and can average five to eight years. First professional degree programs in law, medicine, dentistry, and other fields usually extend over a three- or four-year period.

All these programs are valuable to the nation, and this report relates to all of them. Its primary focus, however, is on the master's and doctoral programs—those programs which both extend the frontiers of knowledge and develop the talent on which creativity chiefly depends. Although distinctions based on the rigor and intensity of master's- and doctoral-level study can be drawn, graduate education includes both, and each contributes to our store of knowledge and trained intelligence.

Commission Charge

The Education Amendments of 1980 set forth the agenda for the National Commission on Student Financial Assistance, including the charge to study and report on graduate education. Issues of financing graduate education frame the charge. The Commission was directed to study the following:

- Adequacy of sources and levels of support for graduate students
- The extent to which talented individuals are dissuaded from graduate study by cost considerations
- Growing levels of indebtedness of graduates
- Underrepresentation of disadvantaged groups in various fields of graduate study

Congress also asked the Commission to address the need for modifications in existing federal student assistance programs, and the need for new programs of graduate student support, especially in the humanities and social sciences.

The health of the graduate education and research enterprise is one of the most significant issues this society faces.

Underlying the specific charge is a deep congressional concern that some of the nation's "most promising students are precluded . . . from developing their capacities and abilities to the fullest possible extent." Congress also expressed its conviction that the major fields of knowledge "need to attract the most able and talented students of each generation if [these fields] are to remain strong and vigorous."

The Report

It is to these underlying issues that the Commission first turns its attention. The report treats the health of the graduate enterprise as a whole and not simply the question of student financial assistance because the problems of the latter make sense only in the context of the former. The Commission maintains, moreover, that to consider research and the graduate preparation of students as distinct and separate matters is to demonstrate a serious misunderstanding of the nature of the entire effort—the two activities are inseparable.

Based on the conclusions emerging from this discussion, the report then addresses graduate policy questions including student financial assistance. The background for the Commission's analysis, along with a discussion of the specifics addressed by the Commission, can be found in the appendixes that complete this volume and the research reports prepared for the Commission.

This report constitutes a reflection on the importance of graduate education and research to our national well-being—to productivity and the economy, to diplomacy and security, and to the quality of American life.

Of necessity, a report such as this represents generalizations about a complex, diverse, and constantly changing reality. Although the Commission believes that its observations are accurate in general, these generalizations do not, and cannot, hold true for every institution or every program. Despite the risk of oversimplifying, the Commission must assert that what it has found is a cause of great concern. The Commission wishes to speak clearly about the dangers the nation runs by continued inattention to the needs of graduate education.

Signs of Trouble and Erosion

In a world of increasing danger, greater complexity, and more difficult national and international problems—of larger risks and opportunities—graduate education is essential for securing the well-being of the nation. In the face of these challenges, our universities are the principal source of the skills and trained intelligence, of the new knowledge and historical perspective—all necessary to define problems, devise solutions, and chart future directions. Our universities, therefore, are a mainstay of our national efforts to strengthen the economy, secure our international position, and improve the quality of American life.

The national asset that is our graduate research and education enterprise was at the heart of our successes following World War II. It is to our universities that we must once again turn if we are to improve our commerce and industry, preserve and defend the nation, conquer disease and malnutrition, and reclaim the environment as well as to restore the intellectual and civic fabric of American society. In each of these areas, our prosperity and progress depend upon new knowledge and new generations of scholars and scientists that only our graduate universities can provide.

But this Commission must report to the American people that it discerns signs of trouble, signs of erosion, in the nation's graduate capacity—signs that in some areas point to serious distress. In the opinion of the Commission, unless our graduate schools receive the support they require, they will not by the year 2000 be able to respond effectively to the nation's imperatives and expectations.

These are strong words. But the warning signs of trouble and erosion can be identified throughout the enterprise: in serious shortages of American doctoral talent in such critical areas as engineering and computer science; in the surrender of our preeminence in high-energy physics to scientists in Europe; in our university laboratories' obsolete instruments, described as "pathetic" by knowledgeable observers; in dramatically reduced faculty turnover that leaves few openings for young and recently trained scholars; in the deteriorating pages of the books in our great research collections; and in what has been called a "state of crisis" in the humanities and social sciences, where the loss of a generation of scholars threatens the existence of scholarship in fundamental fields of knowledge.

Unless our graduate schools receive the support they require, they will not be able to respond to the nation's imperatives and expectations

Discouraging as these realities are, the Commission's concern should not be interpreted as unrelieved pessimism. The Commission is convinced that, despite neglect, the graduate enterprise is still fundamentally sound. Evidence of its continued vitality can be seen in the eagerness with which foreign nationals flock to American universities; in the burgeoning development of technologies—computerization and microcircuitry, robotics, and telecommunications—based on American research; in the "green revolution," which multiplied crop yields many times over; in our increased understanding of the fragile nature of the air we breathe and the water we drink; and in the general tone and quality of the nation's intellectual life and civic discourse.

The Commission is concerned that all of us apprehend the critical importance of graduate education to our national life and understand clearly the gamble we take if we do not respond when the enterprise is in distress.

The problems identified in this report, although serious, represent initial signals to which all of us must attend. The objective of the Commission is to assure that, ten years from now, the nation not look back on these signals as the alarm it failed to heed.

In light of its findings and its extensive research, the Commission sounds this warning to all who care about America's future: Our graduate enterprise is troubled; so is our national capacity to face and master change, to chart and define the future, and to enjoy the rich blessings of democracy secure in the knowledge that others will not create the future for us.

Importance of Graduate Education and Research

Most Americans are aware in a general way of the importance of the graduate enterprise to the nation. We realize that such triumphs as putting footprints on the moon, implanting artificial hearts, and orbiting satellites are the results of scientific and technological brilliance. We may also understand that these developments could not have been conceived, much less realized, without new generations of scholars and scientists making dramatic intellectual progress in areas such as materials and metals; human physiology and behavior; astronomy; systems management; mechanical, electrical, and chemical engineering; and the chemistry and physics of energy.

The nation's universities, fueled by generous public support for research and a constant stream of talented young scholars intent on pushing back the limits of our knowledge, were the engines of that progress.

Bedrock of Our National Life

Few of us comprehend, however, that graduate education and research are the bedrock of every important area of our national life. They support our commerce and industry, are crucial to our foreign policy and security, and are the foundation of our hopes for enhancing American life and culture.

The record vividly demonstrates the contributions of graduate research and education to the nation's well-being:

- In the period of unprecedented national economic expansion following World War II, the number of Nobel Prizes awarded American scientists increased nearly five-fold, while Americans could claim credit for 65 percent of the major technological innovations of the period.

- The United States today enjoys a large favorable balance of payments in commodities relying heavily on advanced chemistry, mathematics, microcircuitry, aeronautics, and metallurgy—commodities such as chemicals and fertilizers, drilling equipment, and aircraft. Computers alone contribute $6 billion annually to our balance of trade.

- American technological supremacy is a major factor in the strategic balance between the United States and the Soviet Union, providing not only the brains and brawn of American weaponry but the eyes and ears of American intelligence as well.

- Agricultural economists have demonstrated the returns to the nation of the green revolution, a marriage of basic science and husbandry. Such developments as dwarf wheat, miracle rice, and other high-yielding crops and strains not only promise richer harvests for all humankind but contribute $18.3 billion annually to our balance of trade as well.

- The interchange of scientists and scholars between and among nations adds to international understanding and can contribute to the relaxation of world tensions.

- Improvements in American health and longevity are based in large part on investments in medical research. Research led to the Salk vaccine, pioneered life-saving techniques in surgery and medical care, and alerted us to the risk to our environmental inheritance.

- In many communities, university museums and programs in the visual and fine arts and the theatre are an important part of local cultural life.

Trained Intelligence

Americans have wisely followed the advice of Alfred North Whitehead who warned that "In the conditions of modern life, the rule is absolute. The race which does not value trained intelligence is doomed."

Robert M. Rosenzweig, president of the Association of American Universities, offered the Commission the same advice when he said: "A simple and clear prescription can serve as a guide to national policy with respect to graduate education. It is this: Attend to the education and training of the nation's best young minds or fall behind those nations that do."

Universities are a mainstay of our national efforts to strengthen the economy, secure our international position, and improve the quality of life.

Investments in graduate education have helped unleash American creativity to our remarkable advantage. Investment is, indeed, the apt term. Funds spent on graduate education and research have not been thrown to the four winds—they have returned dividends to all of us, many times over, in our material well-being, our security, health, and prosperity.

We can all take pride in the past contributions of graduate education and research. But as we look to the perils, problems, and opportunities of the future, it is clear that we will need to redouble our efforts to sustain and nurture this great national resource.

The Economy

Graduate research and education were major springboards from which we launched our extraordinary economic growth following World War II, and they will play major roles in our future economic success.

Economists have demonstrated that enhancing productivity is one of the keys to improving economic performance. Many hold to the proposition that, in advanced industrial nations, economic health will depend on two factors: first, increasing the value of human time by encouraging the creativity that leads to invention and technical innovation; and, second, enhancing productivity through technology.

Products of such creativity and technology are already visible. They can be found in the electronics of 24-hour tellers; in office word-processors and copiers; in the micro-switches that enable us to dial around the globe; and, in our factories, where robotic machines cast our tools and weld our metals.

These developments are but a start. Looking to the future we can already discern the critical importance of research and advanced training to our economic strength:

- The American Society of Engineers estimates that by the end of the decade, 50 percent of the positions available on the plant floor will be held by highly skilled engineers and technicians servicing and maintaining the computers and robots actually producing the nation's durable goods.

Funds spent on graduate education and research have not been thrown to the four winds—they have been returned to all of us many times over.

- Research and development of computerized die-making are widely regarded as keys to the revitalization of the ailing American machine-tool industry, a crucial economic force in its own right and an essential component of our national productive capacity.

- The nation's economic race is against restless competitors overseas, determined to overtake our preeminence in microcircuity and computing power, and to reap the trade benefits of such advances in technology as the "fifth generation" computer.

- The commercial possibilities of research in molecular biology and biotechnology—of improved livestock, of pest-resistant, self-fertilizing crop strains, and of bacteria that will "eat" oil spills and pollutants—have encouraged the du Pont Company, the Celanese Corporation, Bristol-Myers, Monsanto, and others, to invest millions of dollars in university and hospital research.

- According to a 1976 report from the National Science Foundation, technological innovation based on research and development "is an important—perhaps the most important—factor in the economic growth of the United States in this century."

Efforts like these are essential to maintaining our trade and commerce amidst the fierce competition of the modern world.

Such developments also demonstrate that our need for individuals educated at the highest level will grow significantly. As Nobel Laureate Wassily Leontief, professor of economics at New York University, told the Commission:

> The continuous uninterrupted creation of well-trained cadres ... of teachers, research scientists, public administrators, and managers for private enterprise is indispensable for healthy economic growth.... The demand for personnel will grow with [the economy]. Taking into account the characteristics of modern technology, we can safely assume that the need for highly trained cadres will increase even faster.

Diplomacy, Defense, and Security

The Commission is particularly concerned that the public understand clearly the importance of graduate education and research to the nation's security, including its foreign policy and intelligence interests. As Secretary of Defense Caspar W. Weinberger told the Commission, graduate education "has a major impact in a major way on national security."

The importance of the graduate enterprise to our diplomacy and security is not restricted to the scientific and technological foundations of our arms and intelligence efforts. Our national security also requires experts trained at the graduate level in a wide variety of other specialties. For example:

- The Department of Defense relies on the industrial base across the country when it purchases equipment, services, and research and development from 238,000 different contractors.

- The government's diplomatic and defense agencies have a prodigious appetite for graduate-trained personnel. There are over 30,000 positions in the federal government requiring foreign language competence, half of them requiring advanced skills for analyzing foreign nations. The Department of Defense alone currently employs 105,000 scientists and engineers, many with graduate training.

- Secretary Weinberger and two former directors of the Central Intelligence Agency, William E. Colby and Admiral Stansfield Turner, agreed that the nation's diplomacy and security require more than engineers, scientists, and foreign language specialists. Our security interests also demand advanced expertise in the history, culture, religion, politics, and economies of other nations.

Each of these leaders, moreover, stressed that the maintenance of a healthy graduate enterprise, independent of the government's immediate and specific requirements, is an essential "insurance policy against the future." Admiral Turner spoke of the need for

The nation's diplomacy and security depend on a core of scholarship and research in all areas

> . . . a reservoir of specialists on almost every country in the world who can understand the politics, economics, history and culture, and who speak the language . . . a reservoir of talent whose concerns span the geography of the globe.
>
> This is absolutely essential to the future of our country, even with respect to relatively obscure nations with little apparent strategic importance because they may be strategically significant in future.

"Who would have guessed two years ago," Admiral Turner added, "that today the Falkland Islands would be a household word?"

Mr. Colby emphasized that it is imperative to "persuade Congress that we can afford to, and—like the Soviets—we need to, educate highly advanced, graduate-trained individuals in a host of specialties." It is quite obvious, he observed, that the universities must train these people: "The government simply cannot."

It seems clear that the nation's diplomacy and security depend in critical ways on a core of scholarship and research in all areas—in science, engineering, foreign languages, and the culture, geography, history, literature, and religions of the world.

American Life

The nature of American life itself, in its material aspects and in general tone and quality, relies on graduate education and research.

Standard of Living

The remarkable material benefits enjoyed by most of us are a consequence of the nation's wealth and natural resources combined with the ingenuity that both invented and applied technology to the routine work of everyday life. Dishwashers, telephones, microwave ovens, and central heating and cooling raise our standard of living and reduce the tedium of daily toil. They also enhance the lives of each of us by freeing time for recreation, leisure, reflection, and study.

No one can doubt that graduate research is also at the heart of the nation's hopes for improvements in health and nutrition, for reclaiming the environment and disposing of toxic wastes, for revitalizing

mass transportation, and for resolving our energy problems. Graduate research is the cornerstone too of our national efforts to eliminate poverty, to improve education, and to create more humane working conditions.

Intellectual Life

The Commission is constrained, finally, to point out that the intellectual and aesthetic vigor of our national life depends on robust graduate scholarship. By expanding our knowledge of ourselves and our place in the world, the arts, sciences, and letters enrich us individually and collectively.

Evidence of the national thirst for the results of scholarship can be drawn from many sources:

- From the extraordinary number of people who, each year, visit the nation's museums—a 1978 survey indicates that 353 million visitors entered our museums, including 158 million to science museums.

- From the millions who view such historical, scientific, and dramatic television shows as *The Ascent of Man*, *The Six Wives of Henry VIII*, and *I, Leonardo*.

- From a little known fact of American life: more Americans attend exhibitions of the visual and performing arts than attend sports events.

- From the large audiences attracted to university and public libraries for lectures, seminars, and exhibits ranging from architecture to zoology.

The nation's interest in a lively intellectual, civic, and cultural life is nourished both directly and indirectly by a vibrant graduate enterprise.

Beyond the instrumental ends of graduate education, we must foster the life of the mind as an important end in its own right.

Core of Scholarship in All Areas of Knowledge

If graduate education is to serve the instrumental ends the Commission has identified, a core of scholarship in all disciplines is essential. For every area of knowledge can contribute to our ability to manage our society and its institutions and to cope intelligently with the complexities of modern life.

History and language are as important to diplomacy and the defense of our borders as are ambassadors, arms, and engineers. Managers who understand human behavior and the anxieties of the technological workplace are as important to our productivity as the technology itself. Literature and philosophy, by expanding our knowledge of ourselves and defining new ways of knowing and appreciating the world, are as critical to our understanding of the universe as are chemistry and physics.

Graduate education adds to our knowledge in these areas, prepares the experts we need, and supplies the undergraduate instructors essential to continuing the enterprise.

But the instrumental ends of graduate education do not fully define the Commission's concern for its health. That concern is larger.

Providing each citizen with an appreciation of the responsibilities of citizenship is a fundamental obligation of education in a democracy. Democracy and education support each other in richly symbiotic ways: the former fosters the tolerance and understanding without which a pluralistic society would explode; the latter frees the mind—and heart—of the bonds of rigid ideology.

The root of the Commission's concern is that the world's wealthiest and most powerful democracy recognize its responsibility to encourage and foster the life of the mind as an important end in its own right. For as the inheritors of the Western tradition, we have an obligation to preserve and enrich that heritage for the generations to come. Our aspiration to be more than a great nation—to be a great civilization—requires that we do no less.

Clearest evidence of these propositions can be found by contrasting our efforts with those of totalitarian regimes. Graduate training and research in many of them are largely confined to specialized institutes established under government direction.

Our support of independent graduate programs across the range of disciplines marks us as a self-confident people, freely following our curiosity and imagination wherever they lead.

Are We Ready?

The challenges pressing us on all sides demand that we ask if we are prepared for the risks and opportunities of the future. Do we possess an adequate supply of the trained intelligence essential to master and advance technology? Are we taking advantage of all the talent available in our society? Do our graduate institutions have the support required to maintain first-rate research at the frontiers of knowledge? Can we point to healthy scholarship in all basic fields of knowledge?

The answer to each of these questions is "No."

Trouble and Erosion in the Graduate Enterprise

Given the importance of graduate education and research to our national aspirations, we must view with grave concern the extent to which we have allowed them to deteriorate in the last fifteen years. At every turn in its hearings and research, the Commission was confronted with signs of trouble and erosion in the graduate enterprise.

The Commission examined many areas in depth. It concluded that if we are to ensure the vigor of graduate education, we must attend to five major problems: (1) shortages of highly trained talent in key fields, such as science and engineering; (2) maintenance of a faculty of high quality; (3) loss of talented students, especially women and minorities; (4) deterioration of the infrastructure that supports graduate research and training; and (5) potential loss of a generation of scholarship in fundamental fields of knowledge, particularly in the humanities and social sciences.

Shortages of Highly Trained Talent

The Commission's attention has been drawn to startling inadequacies in the numbers of new doctoral-level scholars in areas critical to many national interests. For example:

- In 1979, only 309 Ph.D. degrees in chemical engineering were awarded in the United States, about half to foreign students, many of whom returned to their native lands. We should be graduating at least twice as many doctoral engineers in this area.

- A representative from the Xerox Corporation testified that the national need for graduate-level computer scientists far exceeds the available supply.

- Other witnesses predicted a shortage of up to 100,000 electrical engineers within a decade, and a Hewlett-Packard Corporation representative warned that existing shortages of graduate electrical engineers and computer scientists place the United States "at a serious competitive disadvantage in the world-wide marketplace . . . jeopardizing our national security."

- We suffer from a severe lack of expertise in many aspects of foreign culture and society. A recent study, conducted by the National Council on Foreign Language and International Studies, points to a serious deficiency of experts on the cultures, economies, and foreign policies of other lands, including those of Asia, sub-Saharan Africa, the Middle East, the Soviet Union, and Eastern Europe.

- Former CIA directors William E. Colby and Stansfield Turner cited shortcomings in our past intelligence on Vietnam and Iran as a consequence of our lack of expertise in both areas and worried that our ignorance of Latin America is "almost boundless."

An example of the serious problems we face is the potential demand for highly trained men and women resulting from very large increases in defense spending. These expenditures will total an estimated $1.8 trillion over five years.

Projected expenditures of such magnitude must raise profound concern that the government's need for engineers and scientists will not be met without draining the nation's campuses and industrial laboratories.

This problem is so grave that the Committee on Armed Services of the House of Representatives warned in April 1982 that "... critical shortages in a variety of skills continue to plague the military.... Greater engineering shortfalls in the future will likely harm the U.S. defense posture."

Of equal concern is the need of the Department of Defense for well-qualified managers to oversee these expenditures. Without such people, the department will be unable to manage effectively its enormous procurement programs. These programs demand skills necessary to evaluate complex scientific proposals, judge their relative quality, and select and monitor the work of contractors. As Marvin Goldberger, president of the California Institute of Technology, told the Commission: "The manpower necessary to spend [defense moneys] wisely is simply not there.... You cannot simply put a blue suit on someone and automatically convert [that person] into a technically sophisticated manager."

The allure of industrial and corporate life for our best faculty is often irresistible; better salaries and laboratories are the most obvious advantages.

The competition among universities, the Department of Defense, and industrial contractors for highly trained engineers and scientists is keen. In this competition, contractors have significant advantages, including the ability to offer attractive salaries, first-rate research assistance, and opportunities to use the most advanced equipment, sophisticated and powerful instruments, outstanding laboratories and libraries.

The Commission is therefore concerned—for all these reasons—that scholars, researchers, and managers prepared at the graduate level be available in numbers sufficient to meet our national needs in science, engineering, and international affairs.

Maintaining a Faculty of High Quality

University leaders also report increasing difficulty in maintaining the high quality of American graduate faculties.

Shortages of doctoral-level scholars in critical fields have serious effects on our national capacity to sustain undergraduate and graduate education. In such areas as engineering and computer science, particularly computer engineering, solid-state electronics, and digital systems, faculty vacancies threaten our capacity to produce enough new scientists to meet national needs. The allure of industrial and corporate life for some of our best faculty members is often irresistible; better salaries and superior laboratories are the most obvious advantages. But the short-term benefits to industry come at the expense of its own long-term needs for undergraduate and graduate scientists and engineers.

In other fields, the problem is nearly reversed. The depressed employment market in the humanities and social sciences, for example, means that faculty turnover is limited; tenured faculty, in effect, block the career progression of younger academics. Many young humanists and social scientists now live lives of quiet desperation, making up a class of itinerant scholars wandering from campus to campus on short-term assignments hoping that a tenured position will, at some point, become available.

Both these developments threaten the high quality of our graduate faculties.

Loss of Talented Students

Our need for trained intelligence in all areas is compelling; yet the nation casually accepts a continuous loss of talent in our educational system.

Leaks in the pipeline can be found at every stage from elementary school through graduate school. At the critical juncture of the undergraduate years and the graduate experience, the leak becomes a rupture.

Without regard to the serious national implications of our inaction, we make little effort to encourage the best young minds of each new generation to refine their skills and intellects on the challenges encountered at the frontiers of knowledge.

The Commission is particularly concerned with loss of talent in three areas: (1) the decline in the numbers of superior undergraduates planning graduate study in the arts and sciences; (2) the small proportions of minorities in graduate school; and (3) continued obstacles to the progress of women in graduate education.

Decline in the Traditional Pool

The depressed state of the academic job market, demographic changes, rapidly escalating costs, and reduced financial aid are the principal factors that have discouraged outstanding students—the traditional backbone of graduate programs—from continuing their studies in the arts and sciences. Many students who, a generation ago, would have pursued advanced studies now avoid graduate preparation because they perceive little future in it.

Gladys Keith Chang Hardy of the Ford Foundation presented the following evidence to the Commission:

- Only 28 percent of the graduate candidates offered admission to the humanities division at the University of Chicago in 1980-1981 accepted the offer; in the social sciences, only 34 percent.

- At Harvard University, only one-third of the *summa cum laude* graduates of 1980 planned traditional graduate study compared to over three-quarters of such students in the 1960s.

Foreign student enrollment is increasing—nearly 50 percent of graduate engineering students are from foreign countries.

- At Dartmouth College, between 1977 and 1978, twenty-five fewer of the top one hundred graduates decided to continue their education in the arts and sciences.

- At Princeton University, the number of graduate humanities applicants dropped 27 percent in the last decade; the number of social science applicants, 33 percent.

Robert L. Sinsheimer, chancellor of the University of California at Santa Cruz, directed the Commission's attention to a similar problem in engineering when he wrote:

> ...university funding for research in engineering is so poor in comparison to that available in industry that it is difficult for graduate programs to compete with industry for outstanding recipients of bachelor's degrees.

Many of the best undergraduates appear to be enrolling in programs such as medicine and law. Although students in these areas must assume large debts to finance their studies, they do so knowing precisely how long their studies will last and approximately what their investment in time, energy, and money will return when they begin their careers.

Foreign Enrollments

One result of the withdrawal of young Americans from the rigors of graduate study is the increasing proportion of foreign students in graduate programs. Nearly 50 percent of all graduate engineering students in America are foreign; in some fields of engineering the proportion is still higher. Foreign nationals, moreover, are to be found more and more frequently on our graduate faculties.

This situation should occasion no surprise. Foreign students support graduate enrollments and, ultimately, compete for vacant teaching positions.

Although there are understandable reasons for the increased incidence of foreign students in graduate school, all of us must view this development with concern. The issue goes beyond the inability of foreign nationals to obtain the security clearances needed for research in

Are we taking advantage of all the talent available in our society?

sensitive areas. Marvin Goldberger of the California Institute of Technology rhetorically underscored the longer-term implications of this trend when he told the Commission: "If we continue on our present course, we are going to have all foreign students taught by . . . foreign faculty, because they are the only ones who have Ph.D.'s."

The Commission certainly does not recommend denying foreign nationals access to American graduate schools. Many foreign students enrich American society by remaining here, and others return to their native lands with new appreciation for the American university and for American life.

The presence of these students reminds us of the high value other nations place on American graduate education. Americans should hold it in no less regard. Our challenge is to make graduate education as attractive an opportunity for our own young scholars as it is for foreign students.

Minority Participation

Anne Pruitt, associate dean of the Ohio State University Graduate School, told the Commission that, of the 31,000 doctorates granted by American universities in 1981, black Americans received only three percent, with Mexican Americans, Puerto Ricans, and Native Americans each receiving less than one percent. By contrast, 12 percent of all doctoral degrees awarded were received by foreign students.

The woeful history of the participation of minorities in graduate training demands attention for several reasons. The president of the American Council of Learned Societies, John William Ward, reminded the Commission that it is essential to include the diversity of all of our peoples and experiences in the intellectual life of the nation. We must, said Dr. Ward, see that "the life of the mind does not become, all unwittingly, still one more instrument of oppression for the disadvantaged and the excluded in our society."

Simple self-interest supports these appeals to the ideals of scholarship and justice; we are surely foolish to tolerate a loss of talent to the nation from any significant portion of the population. That segment is large and growing. By 1990, according to Commission consultant Harold Hodgkinson, minorities will constitute up to 25 percent of our total population and up to 30 percent of our youth. In some states,

particularly Texas and Florida, minorities will approach 45 percent of the youth population.

The Commission does not underestimate the practical difficulties involved in this challenge. Addressing it will require improving pre-collegiate and undergraduate education for minority groups and more counseling and support services. Despite the difficulties, we must act.

Opportunities for Women

The situation for women is similar to that of minority groups. Although considerable progress was made in raising the participation rates of women in graduate programs in the late 1960s and early 1970s, the gains slowed recently, and some fields of study have made little progress.

According to testimony presented to the Commission by Lilli A. Hornig, executive director, Higher Education Resource Services of Wellesley College, women make up about half of all graduate students, receive half the master's degrees awarded and one-third of the doctorates. Women, however, are overrepresented in such areas as education and the social sciences. They are hardly represented at all in the physical sciences and engineering, receiving only 3.7 and one percent, respectively, of the doctorates awarded in these fields.

The Commission believes that, in responding to the difficulties facing women graduate students in these fields, particular attention should be paid to (1) the possibility that women's loan burdens may be proportionately greater because their anticipated lifetime earnings are smaller; (2) cultural factors that discourage many women from considering careers in science and engineering; and (3) biases in favor of men in the awarding of fellowships and research assistantships.

Deterioration of the Infrastructure

The Commission notes that our unwillingness to provide the tools essential to a first-rate graduate enterprise may make excellence in graduate education a receding goal. We jeopardize our ability to produce the best when we try to get by with second- and third-rate equipment, obsolete instrumentation, and inadequate library collections.

We cannot have a first-rate graduate enterprise with second- and third-rate equipment and facilities.

The evidence presented to the Commission in each of these areas is sobering.

Equipment and Instrumentation

The material needs of advanced scientific investigation are vast, growing, and in some cases staggeringly expensive. As evidence, the Commission points to the announcement of American physicists in the summer of 1983 that, if the United States is to regain its preeminence in high-energy physics, $2 billion is required to build a particle accelerator.

Our investment in such sophisticated, expensive, and powerful equipment and instruments is inadequate. It is not simply a matter of not keeping pace—our penury has led to a situation in which many existing instructional laboratories and much of the equipment and instrumentation currently available are obsolete and insufficient to the tasks at hand. The situation is so serious that in 1981 Senate testimony, George A. Keyworth II, science advisor to the President, described the status of research facilities at American universities as "disgraceful."

The Commission's findings fully support this assessment:

- One major survey indicates that university instrumentation inventories are nearly twice as old as those of leading commercial laboratories.

- A substantial backlog of need for research facilities and equipment has accumulated—one survey of fifteen institutions indicates that their need for funds over the next three years is almost *twice* what they have spent in the last four simply in the fields of biological, chemical, and earth sciences, engineering, physics, and medicine.

- Since 1975, when the University of California estimated that 25 percent of its equipment and instrumentation was obsolete, obsolescence has claimed an additional 5 percent each year. Yet the annual state appropriation for equipment replacement has averaged only 1.7 percent of total replacement costs.

- The dean of engineering at a leading state university told the Commission that 80 percent of the $30 million in equipment on his campus is at least twenty years old.

Thomas Kailaph, associate chairman of the Department of Electrical Engineering at Stanford University, testified that when the Department of Defense announced a $13 million initiative for engineering equipment, it received requests totalling over $1 billion.

Those concerned with excellence in our graduate enterprise must give the most serious consideration to a 1980 survey on the instrumentation needs of universities conducted by the Association of American Universities. The survey reported the following:

> The best-equipped industrial laboratories surpass almost all university laboratories visited. One university researcher captured the sense of disparity and observed, "The ivory towers are now in industry."... When asked to contrast their laboratories, a number of university researchers stated that many, most notably those in Japan and West Germany, are now superior.

Library Collections

Independent scholarship at the graduate level is impossible without first-rate, up-to-date library collections. Equally important, many of these collections are unique and irreplaceable, a point President Reagan stressed when he told a December 1982 meeting of the directors of thirteen research collections: "Our research libraries are repositories for the accumulated knowledge and teachings of civilization. We owe it to ourselves and our children to preserve these rich treasures for the generations to come."

But like everything else, the cost of books and library services has been going up in recent years. Libraries are hard pressed to provide the public and scholars access to their collections and, in the face of an explosion of published knowledge, to maintain current collections.

For several reasons, libraries also find it difficult to take advantage of new technologies for bibliographic and indexing improvements and for cooperative arrangements to create networks of knowledge. Some of

We suffer from a serious deficiency of experts on the cultures, economies, and foreign policies of other lands.

the pressures with which university research collections must contend include the following:

- Although expenditures for library materials rose by 91 percent in the 1970s, enormous cost increases forced a reduction of 20 percent in growth of new volumes.
- Expenditures for salaries and wages more than doubled in the same period although staff size increased only 11 percent.
- Far from preserving these collections for future generations, we are permitting them to deteriorate on the shelves. Acids used in paper since about 1850 are literally destroying irreplaceable collections.

Threat to Scholarship

Under the depressed conditions of much of the academic job market, it is hardly surprising that promising undergraduates avoid graduate study in many disciplines. But the long-term consequences of this situation for the nation are not acceptable. The talents of potential young scholars are forfeited.

The effects of these trends are predictable:

- A 1978 report from the Carnegie Council on Policy Studies in Higher Education warned of a "lost generation of scholars" as young college graduates, wary of embarking on ten or more years of graduate study in fields with remote employment prospects, turn to other endeavors. Derek Bok, president of Harvard University, in a recent annual report, sounded the same somber note.
- Echoing this theme, John William Ward told the Commission that "the state of foreign language study in the United States is scandalous.... There's an area where we are about to lose a generation of graduate students.... It seems to me the United States is choosing to retreat into an intellectual withdrawal."

- Theodore J. Ziolkowski, dean of the Graduate School at Princeton University, told the Commission that entire fields of study are no longer offered on some campuses: Slavic language study has been discontinued at Princeton; other universities are dropping graduate programs in the history of science and East Asian studies; enrollments in economics, history, English, and sociology are maintained only with foreign students.

How Did This Happen?

If we are to find our way out of the predicament in graduate education, we must understand how we got into it. Our situation can best be appreciated as the consequence of a combination of demographic shifts, changes in the academic employment market, cost problems, and unstable federal support.

Demographic Shifts

Until shortly before World War II, the graduate enterprise in America was a relatively obscure aspect of our national life. Following the war, the nation, impressed with the potential contributions of graduate education and research to the resolution of national problems, undertook modest investments in the support of research and of students. After 1958, these investments grew dramatically for two reasons. First, the Sputnik crisis helped alert the nation and its leaders to the need for sustained research in engineering and science. Second, the maturing postwar "baby-boom" generation began crowding our undergraduate programs, requiring a massive expansion of the graduate effort in order to provide an adequate supply of undergraduate teachers.

The Academic Market

Federal support for graduate education reached its peak in 1969. Then much of it was withdrawn, largely from the fear that too many graduates holding Ph.D.'s would saturate the academic job market. Clearly there were sound policy considerations behind this decision. Demographers could foresee the leveling off of undergraduate enrollments and declining employment opportunities for Ph.D. holders in several fields.

Although for the rest of this decade academic placement rates in certain fields will remain depressed, it is also clear that as the children of the "baby boom" generation reach college age in the 1990s, the demand for graduate and undergraduate faculty will again increase. If the nation continues its present course, it will not have enough faculty members to meet the demands of the academic market as this century ends. The implication is obvious. In light of the length of time required

Federal reductions in graduate student support have coincided with dramatic increases in tuition.

to complete a doctoral degree, we must, if we are to provide the faculty needed in the next decade, begin to prepare them now.

Federal Support

The unstable nature of federal support of the graduate enterprise has had serious effects. Under the goad of the Sputnik crisis, the federal government rapidly increased its support of graduate research and graduate students.

Then, in a reversal of policy in the late 1960s, the federal government sharply reduced its support for the graduate enterprise. For example:

- Between 1967 and the mid-1970s, basic research support from the Department of Defense dropped nearly 50 percent in real dollars—from $1.15 billion to $600 million.

- According to the Library of Congress, the combined civilian research and development expenditures of France, West Germany, Japan, and the United Kingdom equaled 125 percent of U.S. expenditures in 1978, compared to 47 percent in 1964.

- Between 1969 and 1978, federal expenditures for university-based foreign affairs research declined from $20.3 million annually to $8.5 million, and funds for facilities dropped from $126 million in 1965 to $32 million in 1979.

Of particular significance is that federal support for fellowships and research assistantships has fallen. Stipends that totaled nearly 80,000 in 1969 have today declined to approximately 40,000.

But withdrawing financial support represents more than an inconvenience to the students. Graduate training, the Commission reiterates, is intimately connected to research. It is not possible to reduce support for students without thereby affecting the basic research endeavor.

The Commission is not advocating a return to the levels of student support of 1969. But the Commission does wish to stress that the sta-

The training of scholars and scientists is a slow process. The young physicists of tomorrow are not yet in high school.

bility essential to research and graduate education is seriously undermined when federal financial support is unreliable or fluctuates rapidly.

The Commission also emphasizes that research and the training of scholars and scientists are slow processes. For example, the particle accelerator sought by American physicists will not be available, under even the most optimistic forecasts, for at least another decade. The young physicists who will first use it are not yet in high school.

This brief history also illustrates the failure of efforts to project accurately national demand for individuals educated through the doctoral level. We have consistently missed the mark—in part because of the inherent difficulties of such forecasts and in part because we have no effective mechanisms for making such estimates on a nationwide basis.

Cost Problems

Finally, cost increases have not only made graduate study very expensive but time-consuming and arduous as well. Given the uncertain employment outlook, it is not surprising that many young scholars today choose not to embark on this course.

Federal reductions in student support, especially for graduate students, have coincided with dramatic increases in tuition costs. Between 1969 and 1981, graduate tuition and fees more than tripled, with average annual increases of about ten percent. During the same period, private institutions raised their tuition and fee levels nearly five-fold, with average annual increases of approximately 12 percent.

The combination of reductions in student aid and rapidly increasing costs has forced graduate students to rely on such "self-help" measures as working, using savings, and borrowing.

Data on the extent of student reliance on these income sources are scarce to nonexistent. The best estimates available to the Commission indicate that the typical graduate applicant for financial assistance has already accumulated significant debts as an undergraduate. Half the graduate business school applicants, for example, have borrowed at least $4,100 as undergraduates; half the medical school applicants have borrowed at least $5,000.

The Commission points out that the financial problems of graduate students are needlessly exacerbated by the application to graduate students of undergraduate regulations regarding eligibility for financial assistance. This problem is particularly acute for first-year graduate students who are ruled ineligible for student aid if they are considered—as most of them are—to have been dependent on their parents in the previous year. The Commission believes that federal policy should recognize that young adults who enter graduate school—many of them starting their own families—are, for all practical purposes, independent.

Goals for Graduate Education: An Agenda for Federal Action

The economic vitality, the security, and the quality of American life depend directly on the capacity of our colleges and universities to produce new knowledge as well as future generations of scholars. We jeopardize these dimensions of our national life if we reject the imperative to exert national leadership in graduate education.

Support of graduate education is not the sole responsibility of any one sector of our society. The federal government, state governments, foundations, and business and industry all have an interest in ensuring the vitality of graduate education. Given the charge to the Commission, however, this report focuses on the responsibilities of the federal government to the enterprise.

Federal support is indispensable to excellence in graduate education.

Such support, moreover, should represent a "balanced portfolio" of funds for both research and student assistance and should be maintained on a stable basis over time.

An Agenda for Federal Action

Testimony before the Commission, research supported by the Commission, its own deliberations, and the work of the staff have convinced the Commission that, in order to meet national needs effectively and to ensure the quality of American graduate education, action by the federal government is essential.

The Commission outlines the following ten goals as an agenda for federal action for graduate education. These goals are designed to

1. Ensure support for talented graduate students
2. Increase the numbers of talented women in graduate education
3. Increase the numbers of talented minority students in graduate education
4. Maintain and enhance the nation's strengths in graduate research
5. Ensure that graduate laboratories, equipment, and instrumentation are of high quality

6. Enhance the quality of scholarly libraries and ensure that valuable collections are maintained
7. Attract and retain promising young scholars as faculty members
8. Meet pressing national needs for highly trained experts
9. Evaluate the impact of the federal government's decisions on the nation's needs for graduate-educated men and women
10. Improve both the quantity and the quality of information about graduate education

The following recommendations to accomplish these goals are, to reiterate, directed largely to the federal government. The Commission also urges action, as appropriate, on the part of state governments, foundations, and business and industry.

A survey of existing federal programs and authorities indicates that much of this agenda can be accomplished without major new legislation. What is required, rather, is adequate support of existing programs. In the following sections, the Commission presents specific steps to accomplish the goals on this agenda and identifies existing federal programs to attain them. In those instances in which legislative authorities are lacking, new programs are described.

Recommendations

1. Ensure Support for Talented Graduate Students

Financial assistance to graduate students is as important as support for research. The costs of pursuing graduate education are high and rising. Unless adequate student aid is available, the nation will not be able to attract the talented young people it needs into graduate education.

The federal government provides financial assistance to graduate students in a variety of ways. Through *fellowships*, a direct grant is made to the student as well as a payment to the institution to help cover tuition and other costs. Several federal agencies sponsor fellowships, most of them in the physical and health sciences and engineering. The National Science Foundation, for example, annually supports about 1,390 students in science and engineering. The National Institutes of Health support approximately 10,000 graduate students and postdoctoral fellows in biomedical and behavioral sciences and in clinical research. Although several federal statutes authorize fellowship support for students in the arts, humanities, and social sciences, few fellowships in these fields are presently funded.

The *research assistantship* is another form of support. Some portion of most research grants to universities assists graduate students in this way. Research assistantships are especially important because they provide both income to the student and research experience in the student's field of specialization. The number of students supported through this mechanism is difficult to determine. In 1981, an estimated 27,000 students worked as research assistants in federally supported research and development projects. National Science Foundation research projects currently support about 9,600 students each year.

A third mechanism of support is the *teaching assistantship*. In 1981, an estimated 54,000 graduate students were employed as teachers of undergraduate classes, laboratory instructors, or tutors. Funds are derived almost solely from the instructional budgets of the colleges and universities themselves.

Three major *federal student aid programs* also assist students in meeting the costs of graduate study. These include the College Work Study program (CWS) and two loan programs, the Guaranteed Student Loan program (GSL) and the National Direct Student Loan program (NDSL).

If we are to maintain a strong system of graduate education, it is imperative that these sources of support be sustained. *In order to assure that sufficient numbers of talented young people enter graduate study in all disciplines, the Commission recommends that major federal programs of support for graduate students should be maintained and, in some instances, substantially increased.*

The Commission makes the following recommendations concerning fellowships:

- The number of science and engineering fellowships in various agencies should be substantially increased, and stipends should be regularly raised to take into account the cost of living. Appropriate consideration should be given to areas within these fields experiencing shortages of doctoral-trained personnel.
- Through the National Research Service Awards program, support for biomedical and behavioral scientists should be maintained at least at present levels.
- For the support of graduate students in the arts, humanities, and social sciences, a total of approximately 750 additional fellowships per year should be provided under the National Graduate Fellowship Program and other appropriate authorities.
- In addition, 500 new one-year awards should be authorized annually for dissertation support of students in the arts, humanities, and social sciences.

Discussion

Inflation takes its toll on graduate students as well as everyone else. The Commission, therefore, recommends that adjustments in stipend levels be made regularly. Failure to do so increases the likelihood that students either will not enter graduate study or, given the attraction of starting salaries in the private sector, will drop out before completion of their studies.

Fellowship awards to students are ordinarily limited to three years. Students in the sciences and engineering are often able to support themselves in subsequent years with *research assistantships*. Such

assistantships are far less available in the arts, humanities, and social sciences. In order to provide modest support to students in these fields during the later years of graduate study, the Commission recommends a new program of dissertation fellowships. These would provide support and an incentive to finish the dissertation as rapidly as possible.

The Commission makes the following recommendations concerning research and training assistantships:

- Increased federal support for research should be accompanied by an increase in the number of research assistants in all fields.
- The College Work Study program should be substantially increased, with a sizable portion of additional funds directed to graduate students. Such funds should be used by institutions to support students engaged in research or teaching in their academic fields.

Discussion

The College Work Study program (CWS) provides part-time employment to needy students, including graduate students. Under CWS, which is administered by the college or university, 80 percent of the student's salary is paid by the federal government, the remainder by the institution. Only 10 percent of the 983,000 students assisted by this program are graduate students. The Commission recommends that increases in this program be used to provide jobs for graduate students that are related, if possible, to their academic work.

The Commission makes the following recommendations concerning federal loan programs:

- Graduate students should continue to be eligible for participation in the GSL and NDSL loan programs. Furthermore, the level of interest subsidized for graduate borrowers should remain the same as for undergraduates—as under current law.
- Limits should be increased on the total amounts that students, particularly professional students, may borrow.

- Graduate students should become eligible to participate in federal student assistance programs immediately upon entering graduate school.

Discussion

Guaranteed Student Loans are made by private lenders and subsidized and guaranteed by the federal government. Five thousand dollars may be borrowed each year, up to a total debt of no more than $25,000. Students make no payments for interest or principal while in school. After students graduate, the interest rate is fixed, presently at 8 percent. A Commission survey of state guaranty agencies indicates that through this program about 410,000 graduate and professional students borrowed $1.6 billion in fiscal year 1982.

The NDSL program provides low-interest loans to needy students. Loans are made by colleges and universities using funds provided by both the federal government (80 percent) and the institution (20 percent). Total borrowing (undergraduate and graduate) is limited to $12,000 per student. In 1983, about 826,000 loans will be made. The portion of these made to graduate students, however, is unknown.

The total amount that students may borrow should keep pace with costs, especially for students in the health sciences. If there is not some modification of loan limits, students will find themselves unable to continue their graduate work. The Commission shares the concern of many that loan burdens of students may become unmanageable. However, analyses completed for the Commission suggest that loan burdens for the vast majority of graduates are not excessive. The Commission, therefore, recommends raising on a regular basis total loan ceilings for individual borrowers under GSL and NDSL.

To be eligible for subsidies in both programs, students must have been independent of their parents for at least a full year before applying for aid. Many students remain dependent on their parents while undergraduates, but for all practical purposes become independent once they enter graduate or professional school. Under current policies, such students are ineligible for consideration as independent students to receive federal support based on need during their first year of graduate study. The Commission believes that, provided they are not claimed as dependents on their parents' income tax returns, these students should be considered independent immediately upon entering graduate school.

2. Increase the Numbers of Talented Women in Graduate Education

Talent lost to graduate education is a loss to the entire nation. The Commission is concerned about the small numbers of women who pursue scholarly careers, particularly in the sciences and engineering. Although progress has been made in recent years, it is not enough.

The Commission makes the following recommendations to increase the numbers of talented women in the intellectual life of the nation:

- Fellowship support for women in graduate education should be increased substantially with particular attention to encouraging women to enter fields of study in which they are presently underrepresented.
- National Science Foundation programs designed to encourage women to pursue careers in science should be continued.
- The federal government and research universities should work together to disseminate information about opportunities in science to women, both undergraduate and graduate.
- Colleges and universities should assume responsibility for providing more research assistantships for women.

Discussion

Direct fellowship support for women is imperative if their participation in all graduate fields is to be encouraged. The Graduate Professional Opportunities Program (GPOP), administered by the Department of Education, provides fellowships for underrepresented groups such as minorities and women. However, this program supports only some 200 women per year. Furthermore, the stipends are significantly smaller than those provided by other federal programs. The Commission recommends increases in both the number of women supported and the amount of the stipend.

In recent years, the National Science Foundation has sponsored a number of programs intended to encourage women to pursue careers in science. For example, the Visiting Professorships for Women in Science and Engineering program creates opportunities for women already established in science to gain greater visibility in the scholarly

community. The Commission recommends continued support for such programs.

The Commission also notes that many undergraduate women do not consider careers in science because they are unaware of special support available to them. The Commission recommends that women be given adequate information about financial assistance for advanced study in science.

Analysis conducted for the Commission also suggests that women do not receive a fair share of research assistantships in proportion to their enrollment in graduate science programs. Without such assistantships, women find it difficult to complete their dissertations and confront another obstacle in pursuing a career in research. The Commission calls upon institutions to recognize and respond to this imbalance.

3. Increase the Numbers of Talented Minority Students in Graduate Education

Although several efforts have been made in recent years to increase minority participation in graduate education, the Commission remains deeply concerned about the small numbers of minority students pursuing graduate studies. Addressing this problem should remain a high national priority.

The Commission makes the following recommendations to increase minority student participation in graduate education:

- Funding for all programs that support minority graduate students should be increased. Specifically, the number of GPOP fellowships available to minority students and the stipend levels should be increased.
- Programs that support minority student participation in law, nursing, medicine, science, and engineering should be expanded.

- The National Institutes of Health grants should be maintained to support undergraduate research training for minorities leading to graduate work in the health sciences.
- Similar undergraduate programs, often called "reach back," should be established for other academic areas, particularly those in which minorities are most seriously underrepresented.
- Support for the improvement of science education programs in predominantly minority undergraduate institutions should be expanded.
- Colleges and universities should provide more research assistantships to minority students.

Discussion

The Commission is convinced that it is essential to support all existing programs that assist minority students in graduate school.

Several of the above recommendations are directed at serious structural problems throughout the educational enterprise, including (1) the need to improve science education for undergraduate minority students, particularly those in predominantly minority schools; (2) the need to provide support and tutorial services for minority students in all institutions; and (3) the responsibility of graduate schools to afford meaningful research opportunities for minority students.

The Commission draws attention to the Minority Institutions Science Improvement Program, administered by the Department of Education. This program provides grants to improve the quality of laboratories and undergraduate science instruction at predominantly minority institutions. Appropriations for this program should be expanded in order to increase the numbers of scientists and engineers from minority groups.

The Minority Access to Research Careers program, administered by the National Institutes of Health, provides support at both the undergraduate and graduate levels for students pursuing a career in the health sciences. Support and services begin at the undergraduate level and continue into the first years of graduate study. This approach could well be emulated in other academic fields by the National Science Foundation, the National Endowments for the Arts and Humanities, and other federal agencies.

4. Maintain and Enhance the Nation's Strengths in Graduate Research

Graduate education and the research that takes place in universities are intimately related. The health of each is directly dependent on the other. A failure to maintain support for research in our universities will inevitably compromise the quality of preparation of graduate students.

The Commission makes the following recommendations to ensure graduate research of high quality:

- Support from the federal government for basic and applied research at colleges and universities should grow with the economy at a rate at least sufficient to keep pace with inflation.

As part of an effort to deal with their own budgetary uncertainties, federal agencies have in recent years increasingly shifted to smaller grants and short-term commitments. These trends have serious destabilizing effects on university research and graduate education.

The Commission makes the following recommendations to ensure stability in the management of federally funded research grants, particularly large ones:

- The federal government should adopt policies and funding practices that ensure stable, long-term support for research and thereby allow for proper planning and management on the part of universities.

Discussion

Sustained federal support for research is needed in all disciplines. If we are to maintain the nation's leadership in science and technology, support for the sciences and engineering is particularly important. Heightened concern for scientific research, however, may lead to a dangerous neglect of research in the arts, the humanities, and the social sciences. The federal government must maintain adequate support for these fields as well.

Corporations also frequently support university research, usually in areas of their interest. Nevertheless, as Simon Ramo of TRW, Inc., the

chairman of President Reagan's Transition Task Force on Science and Technology, has observed: "The government, and not competitive industry, is the proper and natural source for funding university basic research. Because it benefits all citizens in the end, it is right for all citizens to share the costs."

Many government research and contracting procedures were originally developed for the procurement of computers, copiers, and coffee cups. Research, however, cannot be quantified or predicted as readily as office furnishings or the contents of supply cabinets. By its nature, research requires a sustained effort, repeated redefinition of the problem, and a willingness to shift directions or even start anew. Uncertainty about anticipated support can seriously undermine the research effort.

In financing research, the federal government should whenever possible undertake multiyear commitments. Such commitments would help those who manage research projects, even when the long-term support is modest in amount.

Periodic reviews of research projects are also essential in order to ensure accountability for public moneys. Federal agencies should schedule such reviews and make decisions about continued support well in advance of the termination of current grants.

5. Ensure that Graduate Laboratories, Equipment, and Instrumentation Are of High Quality

Graduate students need adequate laboratories, equipment, and instrumentation to pursue their studies. Indeed, if excellence is to be the hallmark of our graduate programs, such laboratories and equipment must be the most advanced possible. Testimony before the Commission as well as its own analyses have identified a serious need to renew the infrastructure of research and graduate education.

The Commission makes the following recommendations to assist colleges and universities in replacing obsolete equipment and instrumentation and in renovating laboratories used for graduate education and research:

- The federal government, utilizing existing legislative authorities, should substantially increase funds for improving and modernizing university laboratories, equipment, and instrumentation.

- Private business and industry should be encouraged to contribute equipment, both new and used, to universities.

Discussion

The federal government presently has legislative authority to assist in the improvement of laboratories, equipment, and instrumentation used in graduate education. Various statutes provide for outright grants, federal loans, and subsidized private loans for construction, renovation, and the purchase of equipment. In fact, a number of agencies already support the updating of equipment and instrumentation: (1) The National Science Foundation supports equipment and instrumentation as a part of its general research grants. In 1982, an estimated $90 million was spent for this purpose. Last year, this figure was raised to $112 million with a projected increase to $180 million by 1984. (2) The Department of Energy and the Department of Defense also have programs of support for university instrumentation; the Department of Defense program is being expanded. The Commission applauds these commitments and urges continued and substantially increased support.

Finally, the Commission notes that laboratories and equipment in industry are often more sophisticated and modern than university facilities. Because future employees are being trained in university laboratories, it is in the interest of private industry to help resolve this imbalance. The Economic Recovery Act of 1981 provides tax advantages to corporations that donate equipment. Recent congressional proposals would expand these incentives. Tax incentives, matching grants from the federal government, and other appropriate mechanisms should be used to encourage such contributions. All of these efforts, however, should include safeguards to ensure that only useful and current equipment is donated.

6. Enhance the Quality of Scholarly Libraries and Ensure That Valuable Collections Are Maintained

Academic libraries also need continuing maintenance and improvement. In many disciplines, library collections are the primary scholarly tool.

The Commission makes the following recommendations to enhance the quality of university libraries:

- The federal government should increase grants for operating support to all college and university libraries, with much larger grants to major research universities.
- The federal government should encourage and support interlibrary cooperation and networking to ensure the widest possible use of scholarly materials.
- Incentives for business and industry to donate equipment to colleges and universities should be extended to apply to library materials and research collections. Again, safeguards would be necessary to prevent the use of such incentives for donations of materials of little value to scholars.
- The National Commission on Libraries and Information Science should continue to work closely with the Library of Congress in monitoring and assessing the quality of the nation's libraries.
- The Library of Congress should take a leading role in assisting libraries across the country to preserve deteriorating collections. The Commission supports the Library's program of research into methods of preservation and encourages the Library's National Preservation Office in its plans for wider dissemination of information.
- Existing programs that support the preservation of scholarly materials, such as the one administered by the National Endowment for the Humanities, should be continued.
- The Library Career Training program should be extended to support advanced study in modern information technology such as computers, library networking, and the preservation of older library materials. Minority participation in the program should be encouraged.

Discussion

Two existing programs can be used to accomplish the first of these recommendations. The College Library Resources program, with a budget of only $1.9 million, provides small, noncompetitive grants to over 2,000 colleges and universities to assist in the acquisition of resources or the establishment of cooperative arrangements for the sharing of materials.

Through the Strengthening Research Library Resources program, larger competitive grants are made to major research libraries to help them maintain or expand their collections. In 1983, less than $6 million was appropriated for this program. Given the urgent need, this level of support is pitifully inadequate.

Yet another effort, the Interlibrary Cooperation Program, supports cooperative arrangements between and among libraries, networking, and the use of computers for cataloging and text storage.

The Commission recommends dramatic increases in funding for all three programs.

Tax incentives to business and industry do not now apply to the donation of library materials or unique scholarly collections. As Congress reviews changes in provisions for the donation of equipment, it should also consider allowing tax incentives for contributions of materials of use to scholars.

The maintenance of quality in our library collections also depends upon the talents and skills of those charged with that task. New information technologies, networking, and evolving techniques for the preservation of collections all require fresh skills and training. Created in the 1960s, the Library Career Training program supports training for such purposes. Unfortunately, in recent years, less than $1 million has been provided for those efforts, a dramatic reduction from past levels of support. The Commission recommends a substantial increase in funds for this program.

7. Attract and Retain Promising Young Scholars as Faculty Members

The continued infusion of talented young people into faculty positions in all disciplines is indispensable to scholarly vitality. It is essential to ensure this flow of talent, particularly in those endangered academic specialities.

The Commission makes the following recommendations to attract and retain talented young faculty:

- Substantial support should be provided for promising young faculty in the sciences and engineering.
- Support for promising young faculty should also be provided to the arts, humanities, and the social sciences.

Discussion

The recently proposed "Presidential Young Investigators" program would make possible substantial support to 200 young faculty researchers for up to five years. Salaries of the participants would come partly from federal funds and partly from matching funds from business and industry. The purpose of the program would be to enhance the attractiveness of academic careers to young scientists and engineers.

The Commission believes that this program should be extended to include young faculty members in the arts, humanities, and social sciences.

8. Meet Pressing National Needs for Highly Trained Experts

We rely on graduate education to produce highly trained experts in a number of fields vital to our national interest.

Two areas are of particular concern at this time: (1) shortages of scientists, engineers, and computer specialists; and (2) a serious and growing lack of sufficient expertise in foreign languages and cultures.

Shortages in sciences, engineering, and computer science have received a great deal of public attention. Numerous proposals have been made to respond to this problem, and many of the recommendations in this report address it.

The Commission makes the following recommendations to meet pressing national needs for foreign area specialists:

- Federal support for research, instruction, and graduate study in a wide range of languages and cultures should be significantly increased.
- Federal support for faculty and teachers to study in foreign countries should be expanded.

Discussion

Our national capacity to understand and communicate with other peoples is threatened by our lack of expert knowledge of the languages and cultures of other nations.

The Language Training and Area Studies program (Title VI of the Higher Education Act) supports research and instruction in modern foreign languages. During fiscal 1983, this program provided $21 million for support of ninety national resource centers, 700 fellowships, and thirty independent research projects as well as a small number of undergraduate programs. The Commission urges support of Title VI programs at significantly higher levels.

Since 1962, study abroad has been supported by the Fulbright-Hays program. Funded in 1983 at $5 million, this program currently assists only about 150 individuals and twenty group foreign study projects. This is an embarrassingly low level of support, and funds for Fulbright-Hays should be dramatically increased.

9. Evaluate the Impact of the Federal Government's Decisions on the Nation's Needs for Graduate-Educated Men and Women

Despite particular shortages that might develop at a particular time, the Commission remains seriously concerned about the lack of any national mechanisms for assessing the impact of federal decisions affecting the need for men and women trained at the graduate level.

The Commission makes the following recommendations to identify possible future shortages and to assist our colleges and universities in responding to changing national needs:

- The federal government should establish a process for regular and systematic assessment of the impact of federal decisions on the nation's need for men and women educated at the graduate level.

Discussion

The Commission proposes that such a process for assessment include an analysis of the needs of federal agencies for highly trained persons as well as an analysis of the impact nationwide of major decisions by the federal government. The mechanisms for such a process should be developed by the government in consultation with representatives of business, labor, and higher education. The results of the analyses should then be widely disseminated to all sectors of society.

The Commission is in effect calling for "educational impact statements" —statements of the impact of federal decisions, especially budgetary decisions, on the nation's educational system and, in particular, on graduate education. The demand created for graduate-educated men and women as a consequence of dramatic increases in defense spending represents just one example, albeit a most important one, of such decisions.

One purpose of these educational impact statements would be to provide colleges and universities the information they require to develop or expand programs and to guide students toward areas of future need. Another use of such statements would be to alert private industry to potential areas of shortage so that corporations can take appropriate steps to meet their own personnel needs.

The Commission is *not* proposing that the government engage in the "manpower planning" common in some other nations. Such planning is often highly detailed and complex, involving targets for the production of personnel based on estimates of future economic needs. What is proposed here is different and more modest. Decisions of the federal government would be analyzed for their impact on the numbers of highly trained people that society needs, and the results of these analyses publicly reported to the institutions most affected.

10. Improve Both the Quantity and the Quality of Information about Graduate Education

In preparing this report, the Commission found even the most basic information about graduate education lacking. For example, federal data about the numbers and characteristics of students enrolled in master's and doctoral programs were last collected in 1976. Little reliable information is available about how graduate students in various fields finance their graduate studies. With the exception of the sciences and engineering, little is known about the career patterns of students after they have completed their master's or doctoral degrees.

In the absence of such information, federal and state governments and universities will find it difficult to develop sound policies.

The Commission makes the following recommendations to increase and improve the quality of information about graduate education in the United States:

- Appropriate departments and agencies of the federal government should work with state governments, colleges, universities, and other organizations to collect the data needed to describe and monitor the overall condition of graduate education.

Discussion

Gathering data about education has, for over a century, been viewed as an appropriate role of the federal government. It is in our national interest to have adequate information about graduate education. The federal government should improve its data collection activities in this important area if the nation is to develop coherent and effective policies for graduate education in the future.

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Appendix A: Witnesses Who Testified before the Graduate Education Subcommittee

(Titles refer to positions at time of testimony)

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January 25, 1983

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University of California System

Marjorie Dickinson
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New York University
March 15-16, 1983

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Joseph Duffey
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University of Massachusetts at Amherst

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Program Officer in Charge of Education and Culture Program
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Henry Hughes
Doctoral student, political science
The City University of New York

Steven Lavine
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The Commission also wishes to thank the following individuals who met with members of the Subcommittee:

Hon. Caspar W. Weinberger
Secretary of Defense

Hon. Lawrence J. Korb
Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics

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Admiral Stansfield Turner, U.S.N. (Ret.)
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Appendix B: Research Papers Prepared for the Graduate Education Subcommittee

Anderson, Raymond B., and Allen R. Sanderson. "Financial Issues in Graduate Education and an Agenda for Research." ED 228958

Bush, Sharon C. "Women in Graduate Education: The Federal Role in Financial Assistance." (Draft only)

Butler-Nalin, Paul, Allen Sanderson, and David Redman. "Financing Graduate Education: Graduate Student Borrowing, Needs of the Disadvantaged and Underrepresented, and the Climate for Graduate Study." (Prepared under contract with the Consortium on Financing Higher Education.)

Davis, Jerry S. "Increases in Pennsylvania Graduate and Professional School Students' Guaranteed Loan Indebtedness, 1976-77 to 1982-83."

Froomkin, Joseph. "Support of Graduate and Professional Students." ED228974

Garet, Michael S., and Paul Butler-Nalin. "Graduate and Professional Education: A Review of Recent Trends." ED228932

Hartle, Terry W., and Richard Wabnick. "The Educational Indebtedness of Graduate and Professional Students." ED228972

Hodgkinson, Harold L. " 'Terrain Paper' on Demography and Higher Education." ED228938

Lee, John. "Description of Graduate Student Characteristics."

All of the reports and papers above are available through Educational Resources Information Center (ERIC), Document Reproduction Service, P.O. Box 190, Arlington, Va. 22210; (703) 841-1212. The document number is listed after each title. If a title does not have a number, it is still being processed and will be available shortly.

Appendix C: Issues Relating to Graduate Student Finance

Size of the Graduate Education Enterprise

Postbaccalaureate education in the United States is a large and varied enterprise. In the fall of 1982, there were 1,368,387 postbaccalaureate students, of which 1,089,962 were graduate students (in the fields of arts and sciences as well as business and education) and 278,425 were students in first professional programs (in medicine, dentistry, law, and theology). In addition to these traditional students in academic and professional programs, there is a large, generally undefined, population of students who are taking advanced course work. For example, the triennial survey by the National Center for Educational Statistics (NCES) counted almost 3.7 million adults with bachelor's degrees enrolled part time or part year in 1981.

The Commission has concentrated most of its attention on graduate education in the arts and sciences. This population comprises approximately 75,100 master's degree recipients (roughly one-fourth of all master's degrees) and 19,700 doctoral degree recipients (approximately 60 percent of all doctoral degrees).

Sources of Support

Financial support for graduate students ("graduate students" will refer to those in the arts and sciences) comes from a variety of sources, primarily from institutions, state and federal governments, families, and the students themselves. Although we are limited in our general knowledge of sources of student support—for example, dollar amounts for each source are unknown—we know a great deal more about the support of individual full-time students in the sciences and engineering. A majority of full-time science and engineering students attending doctorate-granting institutions receive some form of stipend (usually including tuition payment) as their primary source of support.* In 1981, 61 percent of these students received some form of fellowship, traineeship, research assistantship, or teaching assistantship.

Institutions and—in the case of public universities, states—provide the largest share of support to graduate students, primarily through teaching assistantships but also via fellowships and research assistantships. Overall in the sciences and engineering, 39 percent of full-time students in 1981 received their primary support from institutional and state sources. The federal government provided the primary support for 22 percent of students in these fields, principally through research assistantships derived from research grants and also from fellowships. Other sources of stipends, including corporations and foundations, supported only 6 percent of science and engineering students in 1981, while foreign sources supported 4 percent. The remainder of primary sources, 30 percent, was derived from various forms of self-support—nonacademic employment, loans, and family resources.

*This support may include a fellowship, which is an award to the student for full-time study without a work obligation; a traineeship, which is similar to a fellowship except that it is generally awarded as part of a block of awards; a research assistantship, which requires work on a research grant in return for tuition and/or stipend; and a teaching assistantship, which requires assisting faculty in instructional activities in return for tuition and/or stipend.

The federal government plays a more significant role in the support of students in the natural sciences and engineering because of the concentration of research grants in these fields. As a result, the level of self-support is relatively low for these fields, compared to the social sciences and humanities, which lack federal research grant funds.

Changing Patterns of Support

Post-World War II to 1958

Until World War II, the graduate enterprise was rather modest in size. A postwar enrollment increase was stimulated by the GI bills. By 1954, 30,000 graduate and professional students were receiving GI bill benefits.

In 1954, only 42 percent of science and 30 percent of humanities graduate students received some form of stipend, while the remainder were self-supported. Most of the stipend support came from universities. Federal stipend funds supported only 10 percent of graduate science students. The major portion of this support was in the form of research assistantships, with only a small number of fellowships and traineeships from the National Institutes of Health (NIH), the National Science Foundation (NSF), and the Atomic Energy Commission (AEC).

1958 to 1970

Higher education as a whole expanded rapidly between 1958 and 1970 because of the impact of Sputnik, an increasing college-age population generating demand for new faculty, and a growing economy needing highly trained people. From 1960 to 1970, total degree credit enrollment increased from 3.6 million to 7.9 million, a rise of 121 percent. Over the same time, total graduate enrollment grew from 314,000 to 816,000, an increase of 160 percent.

During this period, support for higher education, primarily from state and federal sources, rose at a faster rate than enrollment. State funding rose at an average annual rate of 12.3 percent to over $3.0 billion by 1970, while federal support rose at a rate of 17.5 percent per year to over $2.6 billion.

Stipend support for graduate students rose dramatically in this period primarily from federal and institutional/state sources. Institutional stipend awards in the sciences rose from approximately 17,000 in 1954 to over 50,000 in 1969.

Federal support rose from approximately 7,500 stipend awards in 1954 to an estimated 80,000 in 1969. (Federal fellowships and traineeships rose from 1,600 to roughly 60,000, and research assistantships rose from 5,900 to 20,000.) Major federal fellowship and traineeship programs included National Defense Education Act (NDEA) Title IV fellowships and Title VI foreign language and area studies fellowships, NSF fellowship and traineeship programs, National Institutes of Health/National Institute of Mental Health (NIH/NIMH) fellowships and training grants, and significant programs in mission agencies such as NASA and AEC.

As a result of these increases, the percentage of full-time graduate science students receiving their primary support from the federal government rose from 10.1 percent in 1954 to 36.6 percent in 1969, and the proportion of students supported by institutional/state sources rose from 25.3 percent to 35.7 percent. Correspondingly, the percentage of students primarily self-supported declined from 58.1 percent to 18.6 percent during this period.

Because the entire spectrum of graduate education was deemed vital to the national interest, all fields, including the social sciences and humanities, benefited in this period.

1970-1981

Graduate enrollments continued to rise in the 1970s, although at substantially reduced rates from the previous decade, and federal support for graduate education began to decline. There were reasons for these developments: *(a)* a worsening labor market; *(b)* declining rates of increase in undergraduate enrollment; and *(c)* economic strains brought on by the Vietnam War.

Federal stipend support declined sharply in fellowships and traineeships in the 1970s, while *federal support through research assistantships actually increased* in the last half of the decade. Federal funds for fellowships and traineeships fell from $430 million in 1970 to $201 million in 1975, a two-thirds decline in *constant* dollars. The number of federal fellows and trainees declined from 60,000 to 24,000 in that period.

Eliminated in the 1969-1975 period were the NDEA Title IV fellowships, NSF traineeships, NIH/NIMH fellowships, and NASA traineeships. Significantly reduced were NSF fellowships and NIH/NIMH/ADAMHA (Alcohol, Drug Abuse and Mental Health Administration) training grants.

More recently, from 1974 to 1981, federal support for fellowships and traineeships in the sciences continued to decline—from 17,000 to 12,800, but research assistantships increased from 21,400 to 27,600. As a result, the percentage of full-time graduate science students receiving their primary support from the federal government fell from 25.5 percent in 1974 to 22.8 percent in 1981. This compares with 36.6 percent in 1969.

All fields of learning have been adversely affected by cutbacks in federal fellowships and traineeships. Hardest hit have been the social sciences and humanities, which did not have the buffer of federal research grants and which had not shared in the growth in research support of previous years.

The overall decline in stipend support was made up by *increases in self-supported students*, whose numbers rose from 43,400 in 1974 to 52,700 in 1981. Moreover, institutional/state support continued to rise. From 1974 to 1981, the number of students receiving their primary support from institutional/state funds increased 18 percent.

Adequacy of Available Sources of Support

It is clear that federal support through fellowships and traineeships has fallen significantly from the era of the late 1960s. That loss has been compensated for in part by federal research assistantships, in part by institutions and state resources, and in part by increases in self-support.

How adequate are the remaining resources to attract highly talented students to meet national needs?

The answer to this question must be based on an assessment of a variety of factors: estimates of national employment trends, the effect of reduced funding on student choice, the impact of increased borrowing, and the availability of alternative sources of support. The first three items are discussed in the body of the report and later in this appendix. The last topic is addressed here by considering the roles of states, corporations, and foundations.

State Support

The level of state support for graduate education is unknown because much state support is subsumed under general instructional budgets.

Although no precise data are available on statewide fellowship programs, it appears that few such programs exist, and those that do offer few fellowships. The State of California, for example, with perhaps the most renowned state university system in the

nation and a higher education budget of $3.2 billion, offers only 800 graduate fellowships per year averaging $3,500 per award.

More recently, many states have become acutely aware of the problem of inadequate mathematics and science education and now see more clearly a direct link among adequate university research, training highly skilled persons, and the growth of their state economies. The available literature indicates that attention at the state level is currently being focused on improving mathematics and science teaching in elementary and secondary schools.

Corporate Support

Corporations support a large but different graduate student population than that discussed above. Corporations tend to support their own employees, who attend school part time while employed and who are likely to take courses at the master's level or to be nonmatriculated, i.e., not enrolled in a specific degree program.

Many corporations offer tuition reimbursement for their employees to undertake graduate training. Currently, 486 of the Fortune 500 companies offer such support. Corporate employees have made extensive use of this opportunity. In 1978, 872,000 employees with four or more years of college education received corporate support for education or training in higher education institutions. This number has increased sharply since 1969 when the number was 360,000. Virtually all of these students attend school on a part-time basis.

Many corporations also provide advanced training themselves for their employees. In 1981, 382,000 employees undertook such training. Most of the corporate support and training programs are focused on the immediate needs of the individual company and on the fields relevant to its business (largely the physical sciences and engineering).

Doctoral students receive little support from business and industry. Only 1.0 percent of the students awarded doctoral degrees in 1981 received their primary support from corporations and only 3.1 percent received any corporate support while they were in graduate school. Most of these students were in the physical sciences and engineering. In engineering, 7.5 percent of the doctoral students received some support from industry.

Corporations are becoming more aware of the importance to their own profitability of academic science and persons trained at the graduate level. As examples: (1) IBM recently announced that it was giving $40 million in computers for the explicit purpose of upgrading graduate training; (2) several drug companies have begun to establish research links with universities, a development which may lead to support for graduate research assistantships; and (3) corporations are participating in state-university initiatives to upgrade engineering research and training. Although corporate involvement in graduate education is growing and is having a salutary effect on shortages in engineering, testimony from corporate representatives makes clear that they see only a limited role for corporations in supporting graduate students.

Foundation Support

Foundations have supported a small fraction of graduate students, primarily full-time doctoral students. Foundations typically support students in fields that have received less support from the federal government, principally the humanities. This emphasis corresponds to the broader cultural concerns of foundations in contrast to the traditionally more utilitarian perspective of the government.

Foundations provided the *primary* support for 1.1 percent of all 1981 doctoral recipients and provided *some* support for 2.9 percent of them. By comparison, in 1972 foundations provided some support to 5.3 percent of students receiving doctoral degrees. Most of these students were in the humanities and social sciences.

The major foundation fellowship programs of the 1960s and 1970s included the Woodrow Wilson Foundation and Danforth Foundation fellowships, which together supported over 21,000 students. Today, a few small fellowship programs exist, notably the new Andrew W. Mellon Foundation graduate fellowships in the humanities and two dissertation fellowships from the Giles Whiting and Charlotte Newcombe Foundations.

Summary

General revenue support from states for graduate education appears to have been relatively strong in the 1970s and acted as an offset to reduced federal support. However, there is little support from state funds earmarked for graduate fellowships. What fellowship support is available appears to be directed to the fields of engineering and high technology.

Corporate support seems focused on areas related to an individual business. Substantial support exists for tuition remission for students enrolled part time; little support exists for full-time doctoral students.

Foundation support is currently limited to a small number of fellowships in the humanities.

Levels of Indebtedness of Graduate Students

Quality of Data

The quality of information pertaining to graduate student indebtedness is poor. For example, the administration's federal budget for fiscal 1984 states that there were 522,000 postbaccalaureate individuals, graduate and professional, who borrowed under the Guaranteed Student Loan program in fiscal 1982, but the Commission, through its own research, reached a figure of 410,000—a discrepancy of more than 100,000 students.

No data base exists that provides accurate figures, either precise or estimated, on the number or percentage of graduate students who borrow, the levels of their borrowing, or, most important, their cumulative indebtedness. Nor are there precise data about the amount of borrowing by graduate students under federal loan programs. Such data are not available either currently or over time.

Context of Borrowing

Borrowing may constitute either a primary source of support or supplement other sources. Although complete data are not available, borrowing is clearly the primary source for a large portion of professional school students and a secondary source for most graduate students. Professional school students tend to borrow consistently throughout their education, while graduate students tend to borrow in their first three years of graduate study.

Most of the borrowing by far is done by full-time students. Data from Pennsylvania and New York indicate that only about 10 percent of the Graduate Student Loan (GSL) borrowers are part time.

Trends in Borrowing

Changes in graduate student borrowing over time can only be guessed at since accurate data are not available. It seems fair to say that borrowing was a minor factor in student finance prior to 1958 when the first federal loan program was instituted. In 1960, a National Opinion Research Center (NORC) survey of graduate arts and science doctoral students indicated that only 13 percent had borrowed at some time during their studies and only 20 percent of the students who did borrow graduated with debts over $1,000. A 1965 NCES survey indicated that only 3.5 percent of full-time graduate student budgets were made up of loans.

Although no reliable trend data are available, it is clear that student borrowing increased during the 1970s. A 1974 study commissioned by the Office of Education to examine the Federally Insured Student Loan (FISL) program found that in 1969 the average loan to postbaccalaureate students (both graduate and professional) was $1,051. Data for fiscal year 1982 from the Pennsylvania Higher Education Assistance Agency indicate that the average GSL loan to postbaccalaureate students was $4,000 per year, ranging from $3,200 for education school students to almost $5,000 for medical school students.

Data also supplied by the Pennsylvania Higher Education Assistance Agency indicate that the number of postbaccalaureate students who borrowed under the GSL program through that agency increased from 4,356 in 1976-1977 to 15,228 in 1982-1983. The average *total indebtedness* of graduate and professional students using the GSL program upon leaving school rose in this period from $4,882 to $10,244.

Undergraduate Debt

NCES survey data indicate that 35 percent of 1980 college graduates had some debt at graduation. The median debt (one-half of the students borrowed more, one-half less) was $2,500. However, 25 percent (upper quartile) of the students who borrowed had accumulated debts that were higher—$3,600 at public institutions, and $5,000 at independent colleges and universities.

Master's Level Debt

NCES data indicate that 23 percent of the 1980 master's degree recipients borrowed (from a low of 20 percent in engineering and education to a high of over 40 percent for those in the humanities and health/biological fields). As one would expect, a higher percentage of students (28 percent) in independent institutions borrowed than those in public institutions (22 percent). Median cumulative debt was $2,700, only slightly higher than for undergraduates.

Median debt for master's degree recipients ranged from a low of $1,600 in the physical sciences to a high of $4,200 in the health/biological fields. In addition, 25 percent of master's student borrowers had much higher indebtedness—$5,000 in public institutions and $6,500 in independent institutions.

Doctoral Level Debt

Data on indebtedness—annual and cumulative—are much less reliable at the doctoral level than at the bachelor's and master's levels, because no comprehensive survey

covers the doctoral population. The most detailed available information on borrowing by doctoral students comes from the Graduate and Professional Students Financial Aid Service (GAPSFAS), a service for students applying for financial aid. GAPSFAS represents a preselected group of likely borrowers. Thus, while detailed information about likely borrowers is available, information about the wider population is not.

One piece of broad-trend data is available from the Survey of Earned Doctorates. It reveals that borrowing remains a small but growing part of the financing picture for doctoral students. Loans were reported used by 25 percent of the 1982 doctoral recipients compared to only 12 percent in 1972. However, only 2 percent of the 1981 doctoral recipients reported loans as their *primary* source of support. Thus, loans appear to be, at most, a secondary source for doctoral students. It should be reiterated, however, that many of these graduates began their studies in the mid-1970s when borrowing levels were lower.

A 1982-1983 Educational Testing Service (ETS) analysis shows that $6,800 was the median cumulative debt of those students applying for need-based aid in their third year of study. The median cumulative debt for third-year applicants was lowest ($5,000) for physical and biological science students and highest ($6,400-$6,500) for humanities and social science students. These figures may reflect the greater stipend support available in the natural sciences. In addition, the upper quartile of borrowers had cumulative debts of at least $10,000.

Debt Burden

"Debt burden" is the portion of a borrower's future earnings that will be needed to repay his or her educational loans. Debt burden is computed by comparing the repayment level of a loan to the level of anticipated income, which will vary according to one's career earnings. Debt burden is thus an indicator of the ability to pay the money owed. ETS made several estimates of debt burden, primarily using current repayment terms for the GSL program, but also using several other repayment plans with varying degrees of federal subsidy. Using a fixed repayment level as in GSL will mean that the debt burden will be highest (in all fields) when a person first enters employment because his or her salary will be lowest then. In later years as one's salary increases, the debt burden will decrease. The more rapid the income rise, the faster the burden will fall.

ETS provided debt burden estimates for engineers with master's degrees and arts and science students with doctorates. For both groups, the debt burden is modest. For engineers with a median debt of $6,375, the debt burden would be 7.8 percent of disposable income in the first year of repayment and end at 2.7 percent in the tenth year. For doctoral recipients in the arts and sciences with an estimated debt of $7,500, the starting burden would be 7.4 percent and decline to 6.1 percent in the tenth year. Of course, some doctoral students have higher cumulative debts than others. In addition, income varies by field within the arts and sciences. Thus, a humanities student with a $10,000 debt would have a beginning burden of 14.5 percent, while a higher income physical scientist with the same debt would have a 9.1 percent starting burden.

These estimates of debt burden for doctoral students contrast markedly with the estimated debt burden for professional school students who have much higher burdens, even taking into account their projected higher earnings. ETS estimates the starting debt burden for lawyers to be 25 percent and for doctors, 21 percent.

Dissuasion of Students from Attending Graduate School on Financial Grounds

Economic Disincentives

One of the mandates of Congress in The Education Amendments of 1980 was to examine the effect of increasing costs of graduate education: Is the nation losing some of its most promising students? The National Commission on Student Financial Assistance commissioned a study on this topic by the Consortium on Financing Higher Education (COFHE).

The COFHE paper discusses a range of financial aspects that might have an impact on graduate school attendance and degree completion and on the quality of students who attend graduate school.

COFHE concludes that the notion of "financial grounds" should be defined more broadly than simply as the financial resources needed to pay the cost of attendance. Such a definition should include all factors that affect the net benefits of attending graduate school, including the following:

1. Foregone income

By attending school, the student foregoes the income that could have been earned on a job. For doctoral education, which takes an average six to eight years to complete, the amount of foregone earnings is substantial.

2. Reduction or loss of financial support

One way to offset foregone income is to provide graduate students with other means of financial assistance such as fellowships and assistantships. Removal of such support significantly increases the cost of graduate education. Similarly, increasing the cost of borrowing or decreasing access to loan capital affects overall costs as well.

3. Poor labor market

The uncertainty of finding a job means that attending graduate school entails financial risk. In addition, a declining market generally means lower salaries relative to other occupations.

All three of these factors—which reduce the financial benefits of graduate school—have existed in the 1970s and early 1980s. The length of time taken to complete a degree has increased in all fields, especially the humanities and social sciences, thereby increasing foregone income. Stipend support has fallen off and been replaced by lesser-subsidized loans or work, while the costs of borrowing have risen. Finally, the labor market has been "soft" for many fields since the 1970s, with sharply curtailed academic employment opportunities and declining salaries relative to private industry.

The cumulative effect of these changes has been to make attending graduate school far more economically burdensome. Stephen Dresch of the Institute for Demographic Studies analyzed the economic returns to graduate (and all higher) education and found throughout the 1970s and into the 1980s rapidly diminishing economic pay-offs to graduate students. Dresch's research indicates that the expected lifetime income of the graduate and professionally educated declined 25 percent relative to that of high school students between 1972 and 1979.

Detrimental Impacts of Economic Disincentives

1. Shortages of Trained Personnel

There is little doubt that financial disincentives—fewer employment opportunities and lower support relative to cost—have had a dampening effect on enrollment and the number of doctorates granted. In the early 1970s, when federal support was sharply curtailed, enrollments and the number of Ph.D.'s granted declined in virtually all fields of the sciences and humanities. The decreases, however, were generally not great, amounting to an overall 10 percent reduction in doctorates between 1972 and 1978. In the mid-1970s, enrollments stabilized and the number of Ph.D. degrees granted leveled off after 1978, with some small increases occurring more recently. It seems clear that, in spite of financial and labor market problems, the size of the doctoral establishment overall has remained relatively stable. Why is this so? There are several possible explanations, all of which are reasonable; however, the relative importance of each cannot be precisely measured.

*Non*financial factors play a role in determining student choice. Because careers for doctoral recipients have a negative rate of return on educational investment, financial rewards are clearly not the sole benefit sought in graduate education. Other benefits are the enjoyment of teaching or research, the prestige of the career, and the ambiance of academic life.

A poor labor market may actually have a positive impact on graduate enrollment. Prolonging one's education in the hope that job prospects will improve may be a response to an uncertain job market.

Moreover, academic departments continue to rely on graduate students to teach undergraduates and perform research. The internal labor market for graduate students within institutions may thus be strong even as the external market is weak.

Finally, it may be the case that students of lesser quality are enrolling in graduate school. While prospective students of high quality may be motivated to attend graduate school, the combined risks of decreased financing and labor market uncertainty may be great enough to induce some of the brightest students to choose alternative careers.

2. Quality of graduate students

Evidence documenting the quality of graduate students is sparse. Much of it consists of the observations of members of the academic community. The commonly expressed belief is that the sciences continue to attract and hold high-quality students while the social sciences and humanities are experiencing greater difficulty.

Test scores. One piece of evidence is a study done by ETS in 1982 for the National Science Board. The purpose of this study was to examine trends of Graduate Record Examination (GRE) scores of applicants for the prestigious NSF merit fellowship program. The results indicate an overall stability of scores over the decade of the 1970s with the natural sciences appearing strong and the social sciences somewhat weaker. GRE scores in sociology and psychology declined somewhat in the late 1970s while economics scores actually increased. These were the only social science fields covered in the study.

Quality of Applicants. The general good health of the sciences seems confirmed by a recent Higher Education Panel (HEP) survey, which indicates that while a majority of institutions believed that there has been no change in the quality of their applicants

and Ph.D. students over the last five years, a significant portion of the remainder indicated that there has been an improvement in quality. These conclusions held true for the top fifty doctorate-granting institutions as well as for all institutions. A similar survey was administered for the humanities. Here, graduate applicant quality was assessed as stable; the quality of Ph.D students was slightly better than five years earlier. The danger signal appeared at the undergraduate level where institutions indicated a major shift in students from the humanities fields to the sciences.

3. Loss of talented undergraduates to other fields

Considerable anecdotal evidence has been reported regarding the deterioration in quality of students in the humanities and social sciences. Robert Goheen, President of the Woodrow Wilson Foundation, has commented that many universities have reported to him that their brightest humanities undergraduates are not going on to graduate study. COFHE reports that at several of its member institutions, the percentage of their best students (Phi Beta Kappas or *summa cum laudes*) who continue in arts and sciences graduate schools has declined markedly over the last five to ten years. The condition of the social sciences was phrased somewhat differently by Kenneth Prewitt, President of the Social Science Research Council, who indicated that a small core of excellent graduate students did continue in the field but that beyond that plateau there was a sharp drop in quality.

Arguments for the deterioration of graduate student quality in the social sciences and humanities thus rest largely on anecdotal grounds. Since it is logical to assume that the availability of support has some relationship to attendance and persistence in graduate school, then the demonstrable decrease in support in the social sciences and humanities may well be affecting quality adversely.

Appendix D: Participation of Minority Students in Graduate Education

Minorities remain significantly underrepresented in graduate education. Although blacks, Hispanics, and Native Americans constitute approximately 19 percent of the U.S. population, they currently receive only 8 percent of the Ph.D.'s awarded. Minority student enrollments and Ph.D. recipients increased in the late 1960s and through the mid-1970s, but progress appears to have halted in the last four years.

Trends in Participation

Doctorates earned by minority students are concentrated in the field of education. Many earn the Ed.D., which is directed toward nonresearch careers. In the arts and sciences, social science is the field with the highest proportion of minority students. Twenty percent of all doctorates awarded to black students were in social science, although even here, they accounted for only 4.4 percent of total social science Ph.D.'s.

Participation and graduation rates of minorities in graduate education have shifted substantially over the past fifteen years. In the period 1967-1972, minority enrollments in graduate and professional schools showed dramatic increases. Those gains slowed in subsequent years, with rates peaking around 1976-1977. From 1978 to the present, rates have declined, at first rapidly, then more slowly. In some areas, modest increases have occurred in the last two years.

Current participation by minorities, however, is still not comparable to their representation in the population. Blacks represent 12 percent of the overall population. In 1978, they constituted 9.7 percent of the undergraduate population. In 1981, blacks received only 4.2 percent of the Ph.D.'s awarded. By field, black students receiving Ph.D.'s ranged from less than one percent in physics and earth sciences to 8.8 percent in education. In that same year, blacks received about 5 percent of all professional degrees granted.

Hispanics received about 1.3 percent of all doctorates in 1979 and 1.9 percent of all first professional degrees. By field, these ranged from less than one-half of one percent of all degrees in engineering to 1.4 percent of degrees in the arts and humanities.

Minority students tend to take longer than white students to earn Ph.D.'s. The median time from entering college to the completion of the Ph.D. for white students is eleven years, while for black students it is about thirteen years. Thus, minority students are older when they complete their graduate degrees. The average age of black students receiving Ph.D.'s is about thirty-seven, five years older than the average for white students.

This is not a record of progress; rather it represents a drifting away from the objective of achieving greater participation by minorities in the arts and sciences.

Barriers to Participation

Nonfinancial

The reasons for the limited participation by minority students in graduate study are complex and diverse. One reason is limited or poor preparation. At the undergraduate level, a disproportionate number of minority students major in fields that do not lead to graduate study. The largest group, for example, majored in business and management.

In addition, minority students are less well prepared for graduate study; they do significantly less well on admissions tests. In the recent Graduate Record Examination, the scores of black students for the three components of the GRE (verbal, quantitative, analytical) are between 140 and 170 points lower than for white students. Hispanic students are lower than white students by between 90 and 115 points. These figures reflect the overall poorer education received by minorities, beginning in elementary and secondary school and often carried over to undergraduate education. This poor preparation is especially acute in mathematics and science where the necessary laboratory facilities and equipment are generally not available.

Another reason for lower participation by minority students is the relative attractiveness of the job market. Extraordinary efforts by employers to meet affirmative action goals in the last decade have made employment rather than further schooling especially attractive for minorities. Thus, highly talented minority students may be siphoned off by business and industry before they enter graduate school.

The overall result is that the pool of talent, both quantitatively and qualitatively, is inadequate to ensure full minority participation in graduate school.

Those minority students who do enter graduate school frequently face the additional handicap of social and academic isolation from the majority of white faculty and students. This problem is particularly acute in the formation of mentor relationships with faculty.

Financial

1. General Support Considerations

The high cost of graduate school and the more limited financial resources of minority families are also important barriers to graduate participation. The financial needs of minorities are, on average, greater than for nonminority families. For example, the median black family income in 1980 was only 57 percent that of white families. Families with less than $10,000 annual income account for nearly two-thirds of the talented and needy graduate students.

Because most minority students are from marginal financial circumstances, their families do not have much economic resilience. Thus, minority graduate students may leave graduate study temporarily or permanently because they either cannot absorb a financial emergency or their families require their financial assistance. This situation clearly contributes to the added average time that it takes minority students to complete their degrees.

The possibility of deep indebtedness and the dubious employment prospects of Ph.D. students combine to present an especially intimidating outlook to minority students considering graduate education.

2. Sources of Support

Information on sources of support for minority graduate students is available for doctoral recipients, but, unfortunately, not for all full-time graduate students.

For doctoral recipients in the arts and sciences, approximately the same proportion of minority students as white students received their primary support from some form of stipend mechanism. In the natural sciences and engineering, roughly 80 percent of both white and minority students had a stipend as their major source of support, while in psychology, social sciences, and humanities, approximately 60 percent had a stipend. Significantly less support appears available for black students in the biological/medical sciences and for Hispanic students in engineering.

Among the various sources of support, minority students have benefited from foundation fellowships, such as those provided in the past by the Ford and Danforth Foundations, targeted to minorities. Other small extant foundation fellowship programs are the Committee on Instructional Cooperation (CIC), in humanities, social sciences, mathematics, and engineering, funded by the Mellon, Lilly, and MacArthur Foundations; the Danforth-Compton fellowships; the National Consortium for Graduate Degrees for Minorities in Engineering (GEM); and the Association for Public Policy Analysis and Management (APPAM), funded by the Sloan Foundation.

Most federal fellowship and traineeship support, for minority students as well as white students, is received in the biomedical and behavioral sciences. This support is provided by the National Institutes of Health (NIH) and the Alcohol, Drug Abuse and Mental Health Administration (ADAMHA). Small federal fellowship programs targeted to minorities exist in NIH, the National Institute of Mental Health (NIMH), and the National Science Foundation (NSF). A somewhat larger program is the Department of Education's Graduate and Professional Opportunities Program (GPOP), which currently supports 800 minority students, primarily in the natural sciences, engineering, and law.

The source most significantly lacking for minority students is university-based support through teaching assistantships, research assistantships (including those funded through federal grants), and fellowships. This deficiency is particularly acute in the natural sciences and engineering and may indicate that less than adequate training is being provided to minority students. The importance of teaching and research assistantships lies in providing the skills that will ensure the productivity of future teachers and researchers. Serious attention should be given by universities and the federal government to creating more opportunities for minority students to receive such assistantships.

Because of their greater financial need, more black graduate and professional students use the College Work-Study (CWS) program than do white students. Cutbacks in CWS have had particularly negative effects on minority graduate students.

Many institutions are trying to compensate for decreases in federal funding for minority graduate students. A survey by the Council of Graduate Schools indicates that nearly 75 percent of schools surveyed in 1982 said they had increased expenditures for minority graduate students; 19 percent maintained the same level. Given the financial constraints on institutions and states, however, it is apparent that they will be able to fill but a small part of the gap created by cutbacks in federal funds.

Appendix E: Participation of Women in Graduate Education

Changes in legal and social attitudes in the past decade have accelerated the participation of women in higher education. Most notable is Title IX of the 1972 Higher Education Act prohibiting sex discrimination in all federally assisted education programs.

Women in higher education now constitute over one-half of the undergraduate population, one-half of graduate students, and one-third of doctoral students. Women are the largest and fastest growing segment of adult learners reentering higher education. Despite considerable progress made in the late 1960s and early 1970s, improvement in female participation has recently slowed, and in some fields been halted altogether.

Trends in Participation

Over the last decade, women reached rough parity with men at the undergraduate and graduate levels. At the graduate level, women earned about one-half of all degrees awarded in 1979-1980, compared to about 40 percent awarded ten years previously. The U.S. Census reports that female participation in higher education in the 25-34 age group rose 187 percent between 1970-1978.

Women's participation in doctoral education has climbed steadily in the last decade, but their distribution among fields has shown little change. In 1971, women earned 14 percent of the total number of doctoral degrees awarded; by 1981, this figure had climbed to 32 percent or 9,872 degrees. Women doctoral students remain heavily concentrated in education, social sciences, arts and humanities, with two-thirds of the recent gain in education and social sciences. An enormous disparity remains in the natural sciences.

National Science Foundation (NSF) data indicate that women pursuing graduate study in doctorate-granting institutions are more likely to enroll part time than are men in almost all disciplines. Women are also more likely to interrupt their graduate studies than are men.

In addition, it takes women longer to earn their degrees than men. The differences between fields are also large, from a low of 6.0 years (median) in chemistry to 13.5 years for education. This differential is attributable to part-time enrollment, greater reliance on self-support, and family/household responsibilities.

Studies indicate women students are less likely than their male classmates to feel confident about their preparation for and performance in graduate studies. This finding holds true across academic fields, class years, and colleges, even when women and men are matched on grade average and graduate plans.

Barriers to Participation

As greater numbers of women enter the higher education system, the postsecondary community has become increasingly concerned about such issues as the continuing low enrollment of women in traditionally male fields, the lack of confidence of women about their preparation for graduate school, and the decline in academic and career aspirations experienced by many women students during their college years.

Factors that account for the underrepresentation and nonretention of women in certain fields of graduate study are complex and interrelated. A combination of sex-stereotyped attitudes and institutional constraints has led to a reduction in the participation of women in graduate education.

Institutional Barriers

Title IX has prompted many institutions to evaluate their policies and practices toward women primarily in terms of legal issues and requirements. More recently, however, institutions have begun to examine the institutional environment—both inside and outside the classroom—in fostering or impeding women students' full personal, academic, and professional development.

Surveys indicate that sex-role stereotyping is prevalent on campus. Alexander W. Astin's, *Four Critical Years: Effects of College on Beliefs, Attitudes and Knowledge* (San Francisco: Jossey-Bass, 1977), an extensive longitudinal study of student development, concludes: "[E]ven though men and women are presumably exposed to common liberal arts curriculum and other educational programs during the undergraduate years, it would seem that these programs serve more to preserve, rather than to reduce, stereotypic differences between men and women in behavior, personality, aspirations and achievement."

Sex stereotyping continues to be prevalent on campus. Because women tend to have discontinuous educational patterns due to family obligations, some faculty believe that investing financial aid and their time is too risky because women are not likely to become productive professionals. However, many studies have demonstrated that almost all women who complete graduate school go on to do productive work in their fields whether or not they marry and have children.

Despite findings that many women graduate students are highly motivated and often begin study with better grades than men, women students report that their seriousness of academic purpose is frequently doubted by faculty. Such factors undermine the strong mentor relationship and solid research training essential to graduate study.

The problem is compounded by the fact that there are so few women faculty role models for women graduate students. Only 10 percent of full-time college and university faculty are women.

Part-Time Status

That women are of necessity more likely to attend graduate school part time means additional problems for them. Many graduate programs are not open to part-time students, and some institutions discourage part-time students by charging them a higher rate of tuition or by stipulating a minimum fee per semester. In addition, some faculty view part-time students as less committed than those able to devote themselves to full-time study.

Inadequate Preparation in Mathematics and Science

Many of the differences in mathematics scores between men and women may be attributable to the exclusion and underpreparation of girls at the elementary and secondary school levels. A 1972 study found that while 57 percent of male applicants had completed four years of high school mathematics, only eight percent of the females had done so.

Women are effectively eliminated from many academic majors because they lack the requisite mathematics background. Women are, in effect, "tracked out" of not only mathematics and natural science disciplines but also the areas of business administration, economics, and technical fields.

More recent research indicates that women choosing nontraditional fields are beginning to achieve higher test scores and degree expectations, to feel themselves better prepared in mathematics, and to achieve higher mathematics grades in high school. Clearly, adequate mathematics and science preparation has become the critical funnel for entrance into high paying professions.

Inadequate Financial Assistance

Compounding the above concerns are modest but persistent inequalities in financial support awarded to women relative to men. Information on the primary source of support reported by the 1981 doctoral recipients suggests that, for the arts and sciences, men in general receive somewhat more financial assistance from the federal government and universities than women, while women have a somewhat greater reliance on self-support.

While federal fellowship support is hardly plentiful, men appear to receive a consistently larger share than women in both the sciences and humanities. On the other hand, women appear to benefit slightly more than men from National Institutes of Health (NIH) traineeships.

The most significant disparity between men and women is in the availability of work-related assistantships. In the sciences and engineering, men appear to have the advantage in research assistantships (both federal and university financed), while women appear to rely more on teaching assistantships. In general, then, the fields that offer the most support and therefore require less self-support are traditionally those with few women. In testimony before the Commission, Dr. Lilli A. Hornig noted the distinctions relevant for the training of women:

> . . . teaching assistantships . . . provide a service to the institution, resulting in a reduced time for study and scholarship. Conversely, research assistantships not only contribute to more rapid degree completion, but also serve to integrate students into the profession; they create a sense of shared enterprise with faculty and peers, enhance opportunities for research accomplishment and publication. . . .

Increasing the participation of women in research training is thus crucial to receiving the highest quality graduate training.

Programs targeted to women graduate students are few in number and small in size. The only extant federal program is the Graduate and Professional Opportunities Program (GPOP) for women and minority students. Currently GPOP supports approximately 200 women graduate students per year.

Appendix F: Bibliography

In addition to the papers it commissioned and the witnesses it heard, the Commission has reviewed the literature relating to national needs for graduate education and the condition of the graduate enterprise. For the reader interested in further examination of the issues relating to graduate education, the Commission offers this selected bibliography of sources.

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